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ON THE REACTIONS OF BOTH THE IONS AND THE NONIONIZED FORMS OF ELECTROLYTES: ON THE REACTIONS OF METHYL IODIDE WITH SODIUM, POTASSIUM AND LITHIUM ETHYLATES AT 0° AND 25°.

DISSERTATION

Submitted to the Board of University Studies of
the Johns Hopkins University in conformity
with the requirements for the degree of
Doctor of Philosophy

by

BESSIE MARION BROWN

Baltimore

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The author takes this opportunity to express her gratitude to Professor Remsen, Professor Morse, Professor Jones, Professor Whitehead, Associate Professor Acree, Associate Professor Lovelace and Dr. Frazer for valuable instruction.

Special thanks are due to Associate Professor Acree at whose suggestion and under whose guidance this work was carried out.

ON THE REACTIONS OF BOTH THE IONS AND THE NONIONIZED FORMS OF ELECTROLYTES: ON THE REACTIONS OF METHYL IODIDE WITH SODIUM, POTASSIUM AND LITHIUM ETHYLATES AT 0° AND 35°.

An entirely new theory concerning chemical reaction was brought out by Acree and Brunel[1] in 1905-06, and Acree and Johnson[2] in 1907, when they showed by experimental evidence that, in some catalytic reactions, the acceleration may take place through the action of both the ionized and nonionized portion of the salt.

Shadinger[3], and later, Nirdlinger, Rogers and Chandler, showed that in absolute alcohol both the 1-phenyl-3-thiourazole anions and the nonionized sodium 1-phenyl-3-thiourazole react with alkyl halides.

In working with the phenolates, Robertson[4] found that both the phenolate ion and the nonionized sodium phenolate react with the alkyl halides, and Marshall, Harrison[5], and Myers observed that both the ions and molecules of sodium ethylate are concerned in the catalytic effect of this compound on the reversible addition of alcohol to acetonitrile, benzonitrile, para brom benzonitrile and others.

Other reactions studied, and which uphold this theory, are those of methyl iodide, ethyl iodide, and ethyl bromide with sodium, lithium, and potassium ethylates at 35°.

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1. Am. Chem. J., 43, 505.
2. Ibid., 38, 359, 360.
3. Ibid., 39, 375.
4. Diss., J.H.U., 1910.
5. Diss., J.H.U., 1913.

[illegible]

[illegible]

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Thalinger[3], and later, Hirdlinger, Rogers and Thendler, showed that in absolute alcohol both the 1-phenyl-2-thiouracole anions and the nonionized sodium 1-phenyl-5-thiouracole react with alkyl halides.

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Other reactions studied, and which upon this theory, are those of methyl iodide, ethyl iodide, and ethyl bromide with sodium, lithium, and potassium ethylates at 25°.

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1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]
5. [illegible]

Any results which shed light upon the mechanism of organic reactions are of such extreme importance, that it was considered advisable to extend this study to other reactions, and to study some of the same reactions at different temperatures.

With this idea in view, the author took up the study of the reactions of sodium, lithium and potassium ethylates with methyl iodide at 0°, and also the effect of added sodium iodide on the reaction between sodium ethylate and methyl iodide at 35°.

If both the ethylate ion and the nonionized ethylate salt react with the molecular alkyl halide, we have two reactions proceeding simultaneously, one proportional to the ionized part of the ethylate, α, and the other proportional to the nonionized part, $1 - \alpha$. It follows that

$$(1) \quad dx/dt = K_i\alpha(C_{ethylate} - x)(C_{alkyl\ halide} - x) + K_m(1 - \alpha)(C_{ethylate} - x)(C_{alkyl\ halide} - x)$$

in which K_i is the velocity constant for the ionic reaction, and K_m is the constant for the molecular reaction, in a normal solution, and x is the change in the concentration in the time t. If A represents $C_{ethylate}$, and B is substituted for $C_{alkyl\ halide}$, we obtain by integration the equation

$$(3) \quad K_n = K_i\alpha + K_m(1 - \alpha) = \frac{1}{At} \cdot \frac{x}{A - x}, \text{ if } C_{ethylate} \text{ is equal to } C_{alkyl\ halide}, \text{ or}$$

$$(3) \quad K_n = K_i\alpha + K_m(1 - \alpha) = \frac{1}{(B - A)t} \ln \frac{A(B - x)}{B(A - x)}, \text{ if } C_{ethylate} \text{ is not equal to } C_{alkyl\ halide}.$$

Substituting the data obtained for t, x, A, and B, we ob-

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If both the ethylate ion and the nonionized ethylate salt react with the molecular alkyl halide, we have two reactions proceeding simultaneously, one proportional to the ionized part of the ethylate, n, and the other proportional to the nonionized part, 1 - n. It follows that

$$(1)\quad dx/dt = K_i n(C_{ethylate} - x)(C_{alkyl\ halide} - x) + K_m(1 - n)(C_{ethylate} - x)(C_{alkyl\ halide} - x)$$

in which K_i is the velocity constant for the ionic reaction, and K_m is the constant for the molecular reaction in a normal solution, and x is the change in the concentration in the time t if A represents $C_{ethylate}$, and B is substituted for $C_{alkyl\ halide}$, as shown by integration the equation

$$(2)\quad K_n = K_i n + K_m(1 - n) = \frac{1}{A(1 - a)} \cdot \frac{a}{t}$$ if $C_{ethylate}$ is equal to $C_{alkyl\ halide}$, or

$$(3)\quad K_n = K_i n + K_m(1 - n) = \frac{1}{(a - b)t} \ln \frac{b(a - x)}{a(b - x)}$$ if $C_{ethylate}$ is not equal to $C_{alkyl\ halide}$.

Substituting the data obtained for a, b, and t, we co-

tain a set of constants for K_n for each concentration of ethylate used. K_n represents the molecular velocity constant, or the velocity which that reaction would have if the concentration were normal, but the ionization corresponded to the concentration 1/V, when V is the number of liters containing one gram molecule. For a complete mathematical and theoretical discussion of these equations, see Johnson and Acree[1], and dissertations of Robertson, and Harrison.

To determine K_i and K_m for the separate ionic and molecular reactions, it is only necessary to substitute the proper values in the following simultaneous equations and solve for K_i and K_m.

$$K_n = K_i\alpha + K_m(1 - \alpha)$$

$$K_n' = K_i\alpha' + K_m(1 - \alpha') \quad \text{etc.}$$

Values for K_i and K_m are thereby obtained for every pair of concentrations, and the average of these is taken as the accepted value.

Robertson discussed the possibility and probability of other reactions taking place simultaneously with those given above. We must consider, for example, the catalytic effect of the salt formed, or even of the ethylate itself, which we could designate as a "salt effect", and perhaps a side reaction, as well, in which olefines may be formed.

Since we obtain, however, from the equations used, two constant values for K_i and K_m, we can state that we have

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1. Am. Chem. J., 37, 410; 38, 358; 48, 352.

[illegible] set of constants for E_0 for each concentration of ethylate used. E_0 represents the molecular velocity constant, or the velocity which that reaction would have if the concentration were normal, but the ionization corresponded to the concentration $1/V$, when V is the number of liters equivalent to the gram molecule. For a complete mathematical and theoretical discussion of these equations, see Johnson and Jorge[1], and dissertations of Robertson and Harrison.

To determine E_1 and E_0 for the separate ionic and molecular reactions, it is only necessary to substitute the proper values in the following simultaneous equations and solve for E_1 and E_0.

$$E_n = E_1 n + E_0 (1 - n)$$

$$E_n' = E_1 n' + E_0 (1 - n') \quad \text{etc.}$$

Values for E_1 and E_0 are thereby obtained for every value of concentrations, and the average of these is taken as the [illegible] value.

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---

1. [illegible]

either two reactions, or two or more sets of reactions, taking place, one being a function of the concentration of the ions, and the other of the nonionized portion.

If K_1 represents the velocity constant of the reaction between the ethylate ion $C_2H_5\bar{O}$ and methyl iodide, we would expect to find experimentally that the value for K_1 is the same whether the methyl iodide is allowed to react with sodium, lithium, or potassium ethylates, although the values for K_m would not necessarily be the same, and might be entirely different.

Probably the best evidence in favor of this theory is the fact that identical values are obtained for the ethylate ion irrespective of the ionization of the ethylate, the character of the metal, and of the value for K_m. For methyl iodide and sodium ethylate at 25°, Robertson obtained the values $K_1 = 0.137$, and $K_m = 0.0594$. The author repeated this work at the very beginning of this investigation, and obtained the values $K_1 = 0.138$ and $K_m = 0.0586$. For potassium ethylate and methyl iodide at 25°, Harrison obtained the values $K_1 = 0.137$ and $K_m = 0.066$. Similar agreement is found for the phenolate ion when potassium, lithium, and sodium phenolates react with methyl iodide and ethyl iodide.

At 0° the velocity of the reaction is very much less, but we should expect to find that the value for K_1 at this temperature is the same whether sodium, lithium, or potassium ethylate is used. Considering the greater difficulty in carrying out these reactions at 0° and the possibility of

either the reactions, or the or most sets of reactions, taking place, are using a function of one or centration of the ions, and the other of the monitoring position.

If T_1 represents the velocity constant of the reaction between the ethylate ion C_2H_5O and methyl iodide, we would expect to find experimentally that the value for T_1 at the same whether the ethyl iodide is allowed to react with sodium, lithium, or potassium ethylates, although the value for T_2 could not necessarily be the same, and might of course be different.

Probably the best evidence in favor of this theory is the fact that identical values are obtained for the ethylate ion irrespective of the ionization of the ethylate, the character of the metal, and of the value for T_2. For methyl iodide and sodium ethylate at 50°, Dorrison obtained the values T_1 = 0.137, and T_2 = 0.0054. The author repeated this work at the very beginning of this investigation, and obtained the values T_1 = 0.136 and T_2 = 0.0052. For potassium ethylate and methyl iodide at 25°, Dorrison obtained the values T_1 = 0.137 and T_2 = 0.082. Similar agreement is found for the phenolate ion when potassium, lithium, and sodium phenolates react with methyl iodide and ethyl iodide.

At 0° the velocity of the reaction is very much less, but we should expect to find that the value for T_1 at this temperature is the same whether sodium, lithium, or potassium ethylate is used. Considering the greater difficulty in carrying out these reactions at 0° and the presentability of

greater errors, the agreement between the values of K_1 for the different ethylates is quite satisfactory. Since viscosity may play an important part in the reaction velocities at 0°, especially in the more concentrated solutions, it will be extremely interesting, as well as important, to obtain all the necessary data, so that corrections can be made for the viscosity.

In Tables I-XV of the lithium series the starred values for K_n are obtained by discarding those constants which correspond to reactions which were allowed to run over night. In these cases the reactions were more nearly complete, the result being that the constants had dropped several per cent. A slight drop was always noticed, but this was usually negligible, or very small, in the dilute solutions. For a complete discussion of the probable causes for this drop in the constants during any specific reaction, see the dissertation of Robertson.

To make the constants from the different concentrations of ethylate comparable, the reactions were allowed to run to about the same percentage completion, which was usually 50 to 60 per cent., and an average value for the reaction velocity was obtained by taking the mean of the constants for the different time periods. It will be seen from the results that it makes very little difference in the calculated values for K_n when these starred values are used in place of the other values.

In the case of lithium ethylate the reaction was so much slower than in the other cases, that it was difficult to ob-

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To make the constants from the different concentrations of ethylate comparable, the reactions were allowed to run to about the same percentage completion, which was usually 40 to 50 per cent., and an average value for the reaction velocity was obtained by taking the mean of the constants for the different time periods. It will be seen from the results that it makes very little difference in the calculated values for β_n when these stagred values are used in place of the [illegible].

In the case of lithium ethylate the reaction was so much slower than in the other cases, that it was difficult to re-

tain the desired time periods, since it was of course impossible to titrate by artificial light. For this reason, in some of the more dilute solutions the reactions were 70 to 80 per cent. completed. But since the constants in these solutions did not decrease appreciably, there is practically no error introduced by using these values for the longer time periods.

It can be seen from the tables that there is very little difference between the values of K_n for the different concentrations of potassium ethylate, and that in some of the more dilute solutions, the values vary to such an extent that they nearly overlap for the different concentrations. The only remedy for this is to diminish the error as much as possible by taking the average of a large number of determinations. It was impossible to use solutions more concentrated than N/4 because the potassium iodide formed precipitated out almost immediately, and the ionization of the remaining potassium ethylate consequently changed. It was therefore thought advisable to find values of K_n for 3N/16 and 3N/32 potassium ethylate so as to give a few more calculated values for K_i and K_m and reduce the error.

By substituting in the equation $K_n = K_i\alpha + K_m(1 - \alpha)$, these values found for K_i and K_m and the values for α and $1 - \alpha$ corresponding to the different concentrations of the various ethylates, we obtain the theoretical values for K_n given on page 45 under the heading "K_n calculated". These are compared with the corresponding values of "K_n found", and the experimental errors are thus obtained.

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By substituting in the equation $K_n = K_1 x + K_2(1 - x)$, these values found for K_1 and K_2 and the values for x and 1 - x corresponding to the different concentrations of the various ethylates, we obtain the [illegible] values for K_n given on page 46 under the heading "K_n calculated". These are compared with the corresponding values of "K_n found", and the experimental errors are thus obtained.

It can be seen from the data given that the work at 0° is not quite as satisfactory as that at 35°.

SALT EFFECT.

Although many theories have been advanced concerning the socalled "salt effect" of neutral salts on certain organic reactions, through lack of sufficient data no very satisfactory explanation has yet been reached.

From the results obtained during the last ten years in this laboratory, however, we can at least point out many errors in the earlier work, and present our own conclusions, which seem to be capable of wider application.

The view adopted by Euler[1] in 1900 was in accordance with the belief of Arrhenius[2] that the salt cation produces this salt effect by causing a change in the ionization of the water. This was the explanation given by Stieglitz to explain the phenomenon of salt catalysis which he found in studying the hydrolysis of imidoester salts[3].

In a full discussion of the subject, Acree[4] has shown that the explanation offered by Euler and Stieglitz is contrary to facts, one of the strongest points against this theory being the experimental data showing that this view calls for a change in the ionization of water many times greater than could possibly be brought about in this way. According to their theory, the same salt in the same concentration should

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1. Z. physik. Chem., 33, 348.
2. Ibid., 1, 110; 4, 226; 31, 197.
3. Am. Chem. J., 39, 39, 166, 403, 437, 586, 719. J.Am.Chem. Soc., 32, 331.
4. Am. Chem. J., 41, 475.

[illegible]

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sometimes cause an increase, and sometimes a decrease in the ionization constant of water.

It is believed by Acree, and this idea is shared by others (see Lapworth[1]), that salt catalysis is a very complex phenomenon, and involves a large number of factors, both chemical and physical, one of the least important being perhaps the change in ionization of the solvent.

In the same article mentioned above[3], some of these different factors which are probably concerned in any salt effect are fully discussed.

In this laboratory, different investigators have studied the effect of certain added salts on the reactions of the alkyl halides with phenolates, ethylates, and urazole salts. They found that the greater part of the effect was perfectly normal in that it corresponded to the change in ionization of the reacting substances, produced by the added salt.

In some cases, however, a small deviation from the calculated amount was observed which was designated as an "abnormal salt effect", and which might be either "positive" or "negative".

Harrison[3], in studying the formation of nitriles from imidoesters by using sodium ethylate as a catalyzer, found that the addition of even several moles of sodium iodide lowered the percentage of ionization of the sodium ethylate, and hence the reaction velocity as calculated, which fact shows that the

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1. Chem. News, 97, 310.
2. Am. Chem. J., 41, 478-483.
3. Dissertation, J.H.U. 1913.

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It is believed by Jones, that this idea is shared by others (see Ingerson[1]), that salt catalysis is a very complex phenomenon, and involves a large number of factors, both chemical and physical, one of the least important being perhaps the change in ionization of the solvent.

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1. [illegible]
2. [illegible]
3. [illegible]

"salt effect" here was "normal". Since in this case K_i and K_m are so nearly equal, even the "normal salt effect" was extremely small.

Robertson[1] found in the reaction of sodium phenolate with certain alkyl halides, that added sodium iodide produced a "positive abnormal salt effect", in other words, the velocity constant was slightly larger than the calculated value.

On the other hand, Chandler[3] found that sodium iodide produces practically the calculated effect on the reaction between 1-phenyl-3-thiourazole and ethyl iodide.

The results obtained by adding different amounts of sodium iodide to the reaction between methyl iodide and sodium ethylate at 35° are shown in tables LXXXIII-CXII and in tabulated form on pages 60-2. In the first column will be found the volume containing a gram equivalent of the sodium ethylate. In the second column is the reciprocal of the concentration of the sodium iodide added, and the third column gives the reciprocal of that concentration of sodium ethylate or sodium iodide having the ionization calculated for either of these electrolytes in the mixture by the use of the isohydric principle.

To give a concrete example of the method used in obtaining the calculated values of K_n, let us consider the case of a solution which is N/32 with reference to both sodium ethylate and sodium iodide. According to the isohydric principle, each electrolyte occupies that portion of the solution which

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1. Dissertation, J.H.U., 1910.
3. Dissertation, J.H.U., 1913.

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The results obtained by adding different amounts of sodium iodide to the reaction between methyl iodide and sodium ethylate at 25° are shown in tables LXXXIII-CXII and in tabulated form on pages 50-2. In the first column will be found the column containing a gram equivalent of the sodium ethylate. In the second column is the reciprocal of the concentration of the sodium iodide added, and the third column gives the reciprocal of that concentration of sodium ethylate or sodium iodide having the ionization calculated for either of these electrolytes in the mixture by the use of the isohydric principle.

To give a concrete example of the method used in obtaining the calculated values of E_n, let us consider the case of a solution which is N/32 with reference to both sodium ethylate and sodium iodide. According to the isohydric principle, each electrolyte occupies that portion of the solution which

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1. Dissertation, J.S.M., 1930.
2. Dissertation, J.C.C., 1940.

is in proportion to the number of ions it furnishes. In this case, then, since the sodium ethylate and sodium iodide are ionized to approximately the same extent, we can say that each of these ionized constituents occupies half of the solution, and the sodium ethylate consequently would have the ionization of a N/16 solution. Then in the equation $K_n = K_i\alpha + K_m(1 - \alpha)$ we would substitute the values of α and $1 - \alpha$ for a N/16 ethylate solution. If the effect of the sodium iodide is perfectly normal, this is the value of K_n which we should obtain experimentally.

It can be seen from the values for K_n found that in every case, the constant obtained is lower than that calculated, the difference being the "auto" or "abnormal" salt effect, which is expressed in the last column on page 61 as a percentage of the theoretical constant. Since the constant is lower than the theory, the catalytic effect of the salt is negative and must decrease the velocity of the reaction.

With any one concentration of ethylate, as for instance with the N/32 solution, the "auto" effect increases with the concentration of the added iodide, but not in a direct proportion. That is, although the addition of 3/32 mole of sodium iodide produces approximately three times the effect of 1/32 mole of added salt, and 7/32 mole about seven times as great an effect as the 1/32 mole, this relationship does not continue to hold, for 15/32 mole produces only eight times, and 31/32 mole only twelve times as great an effect as does the 1/32 mole of sodium iodide. In similar work with the N/16 sodium ethylate, while 3/16 mole of added salt produces nearly

is in proportion to the number of ions it furnishes. In this case, then, since the sodium ethylate and sodium iodide are ionized to approximately the same extent, we can say that each of these ionized constituents occupies half of the solution, and the sodium ethylate consequently would have the ionization of a 5/16 solution. Then in the equation $K_m = K_1 a + K_2(1 - a)$ we could substitute the values of a and 1 - a for a 5/16 ethylate solution. If the effect of the sodium iodide is perfectly normal, this is the value of K_2 which we should obtain experimentally.

It can be seen from the values for K_2 found that in every case, the constant obtained is lower than that calculated, the difference being the "auto" or "abnormal" salt effect, which is expressed in the last column on page 21 as a percentage of the theoretical constant. Since the constant is lower than the theory, the catalytic effect of the salt is negative and must decrease the velocity of the reaction.

With any one concentration of ethylate, as for instance with the 5/32 solution, the "auto" effect increases with the concentration of the added iodide, but not in a direct proportion. That is, although the addition of 1/32 mole of sodium iodide produces approximately three times the effect of 1/32 mole of added salt, and 7/32 mole about seven times as great an effect as the 1/32 mole, this relationship does not continue to hold, for 15/32 mole produces only eight times, and 31/32 mole only twelve times as great an effect as does the 1/32 mole of sodium iodide. The similar work with the 5/16 sodium ethylate, which 5/16 mole of added salt produces nearly

three times the effect of 1/16 mole, 7/16 mole gives only three and one half times, and 15/16 mole only six times as great an effect.

These figures naturally suggest that the "auto" effect is a function of the ionized portion of the added salt, since the effect decreases with increased concentration in the same manner as would be expected from the suppression of the ionization. It will be shown in equations developed below that the greater portion of the "abnormal" effect of the salt does appear to be a function of the iodide ions.

It must be constantly be borne in mind, in applying this data to such generalizations, that the "abnormal" salt effect is only a very small part of the whole effect of the salt on the reaction velocity, and since the numerical value of this "auto" effect is obtained by subtracting the K_n found from K_n calculated, an error of one per cent. in the velocity constant would constitute an error of fifty per cent. in the "abnormal" salt effect obtained by adding 1/32 mole of sodium iodide to the N/32 sodium ethylate. Consequently from these figures only an approximation can be made concerning the actual effect of the salt, but we can at least obtain some idea of the direction and magnitude of this effect.

By taking the sum of all the percentage lowerings found in the case of N/32 ethylate and dividing this sum by 57, since 57/32 moles of sodium iodide were added in all, we obtain as a result 1.15 which can be considered the average effect of 1/32 mole of sodium iodide in a N/32 ethylate solution. In the same way we obtain 0.86 as the average effect of 1/32 mole of sodium

three times the effect of 1/10 mole, 7/10 mole gives only three and one half times, and 13/10 mole only six times as great an effect.

These figures naturally suggest that the "auto" effect is a function of the ionized portion of the added salt, since the effect decreases with increased concentration in the same manner as would be expected from the suppression of the ionization. It will be shown in equations developed below that the greater portion of the "abnormal" effect of the salt does appear to be a function of the iodide ions.

It must be constantly be borne in mind in applying this data to such generalizations, that the "abnormal" salt effect is only a very small part of the whole effect of the salt on the reaction velocity, and since the numerical value of this "auto" effect is obtained by subtracting the K_2 found from K_1 calculated, an error of one per cent. in the velocity constant would constitute an error of fifty per cent. in the "abnormal" salt effect obtained by adding 1/32 mole of sodium iodide to the M/32 sodium ethylate. Consequently from these figures only an approximation can be made concerning the actual effect of the salt, but we can at least obtain some idea of the direction and magnitude of this effect.

By taking the sum of all the percentage lowerings found in the case of M/32 ethylate and dividing this sum by 57, since 57/32 moles of sodium iodide were added in all, we obtain as a result 1.13 which can be considered the average effect of 1/32 mole of sodium iodide in a M/32 ethylate solution. In the same way we obtain 0.68 as the average effect of 1/32 mole of sodium

iodide in the N/16 ethylate, 0.74 for the N/8 ethylate, and 0.65 for the N/4 solutions. It would appear that the salt effect is not merely a function of the added iodide but of the ethylate concentration as well. These facts seem to contradict the Spohr[1] hypothesis. His work seemed to show that a definite concentration of sodium chloride added to different concentrations of hydrochloric acid produced a specific effect on the reaction velocity of the inversion of cane sugar, irrespective of the concentration of the acid, and therefore of the actual velocity of the reaction.

If the $C_2H_5\bar{O}$ and the iodine ion, $\bar{I}$, each have an independent catalytic effect on the two reactions taking place which we represented by K_i and K_m, we could then express this condition by the following equation,

$$K_n' = [K_i\alpha + K_m(1 - \alpha)][1 + K_sC_s\alpha' + K_eC_e\alpha]$$

in which K_n' represents the actual velocity constant obtained when sodium iodide is added, and K_s and K_e are the constants referring to the catalytic effect of the iodide and ethylate ions respectively. C_s is the concentration of the added salt, α' its ionization, C_e the concentration of the ethylate, and α its ionization. By substituting the found values for K_n and the known values for K_i, K_m, α, $1 - \alpha$, and α', we obtain a series of simultaneous equations which can be solved for K_s and K_e. The values for K_s and K_e obtained were constant in most cases. It must be understood that the error in certain cases might be such as to give values for K_s and K_e which did not seem to fit into this scheme. If we take $K_s = -70$ and

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1. J. prakt. Chem., 32, 33; 33, 365.

iodide in the N/12 ethylate, 0.74 for the N/8 ethylate, and 0.66 for the N/4 solutions. It would appear that the salt effect is not merely a function of the added iodide but of the ethylate concentration as well. These facts seem to contradict the Spohr[1] hypothesis. His work seemed to show that a definite concentration of sodium chloride added to different concentrations of hydrochloric acid produced a specific effect on the reaction velocity of the inversion of cane sugar, irrespective of the concentration of the acid, and therefore of the actual velocity of the reaction.

If the $C_2H_5\bar{O}$ and the iodine ion, $\bar{I}$, must have an independent catalytic effect on the two reactions taking place which we represented by K_1 and K_m, we could then express this condition by the following equation,

$$K_n' = [K_1\alpha + K_m(1 - \alpha)][1 + K_e C_e \alpha' + K_e C_e \alpha]$$

in which K_n represents the actual velocity constant obtained when sodium iodide is added, and K_e and K_e are the constants referring to the catalytic effect of the iodide and ethylate ions respectively. C_e is the concentration of the added salt α' its ionization, C_e the concentration of the ethylate, and α its ionization. By substituting the found values for K_n and the known values for K_1, K_m, α, $1 - \alpha$, and α', we obtain a series of simultaneous equations which can be solved for K_e and K_e. The values for K_e and K_e obtained were constant in most cases. It must be understood that the error in certain cases might be such as to give values for K_e and K_e which did not seem to fit into this scheme. If we take $K_e = -70$ and

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1. J. Prakt. Chem., [illegible], 383.

$K_e = -40$ as averages for the values thus obtained, we can then substitute them in the above equation and calculate our values for K_n' which we should obtain experimentally if the equation holds. The table on page 62 shows the calculated and found values with the percentage error.

$K_s = -40$ as averages for the values thus obtained, we can then substitute them in the above equation and calculate our values for K_n which we should obtain experimentally if the equation holds. The table on page 53 shows the calculated and found values with the percentage error.

EXPERIMENTAL

Preparation of materials. The method used in preparing the solutions and carrying out the reactions at 35° is described in detail by Robertson[1].

The methyl iodide used was of special purity obtained from Hoffmann and Kruff. To insure a large yield of a constant boiling material, two kilograms of the alkyl halide were shaken with dilute sodium carbonate solution to remove any traces of hydriodic acid, washed twice with water, and then shaken for a few minutes with anhydrous sodium sulphate, and filtered through glass wool. A considerable quantity of phosphorus pentoxide was added and allowed to remain over night, after which the methyl iodide was distilled. This treatment with the phosphorus pentoxide was repeated, and the product thus obtained was fractionated. Special care was taken to have the condenser and all apparatus perfectly dry, and, with these precautions, a product was obtained, the total quantity of which boiled within a few hundredths of a degree. A table is given below showing the boiling points of the different fractions, the barometric pressure and the boiling points at 760 millimeters after all the necessary corrections are made.

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1. L.c.

EXPERIMENTAL

Preparation of materials. The method used in preparing the solutions and carrying out the reactions at 40° is described in detail by Robertson[1].

The methyl iodide used was of special purity obtained from Hoffmann and Kraft. To insure a large yield of a constant boiling material, two kilograms of the ethyl iodide were shaken with dilute sodium carbonate solution to remove any traces of hydriodic acid, washed twice with water, and then shaken for a few minutes with anhydrous sodium sulphate, and filtered through glass wool. A considerable quantity of phosphorus pentoxide was added and allowed to remain over night, after which the methyl iodide was distilled. This treatment with the phosphorus pentoxide was repeated, and the product thus obtained was fractionated. Special care was taken to have the condenser and all apparatus perfectly dry, and with these precautions, a product was obtained, the total quantity of which boiled within a few hundredths of a degree. A table is given below showing the boiling points of the different fractions, the barometric pressure and the boiling points at 760 millimeters after all the necessary corrections are made.

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1. L.c.

Observed B.pt.	Barometer	Corrected B.pt.
43.80 - 43.83°	769.4 mm.	43.17 - 43.30°
43.83 - 43.83	769.3	43.19 - 43.30
43.83 - 43.81	769.3	43.30 - 43.19
43.81 - 43.81	769.3	43.19 - 43.19
43.93 - 43.91	771.3	43.31 - 43.31
43.91 - 43.86	770.6	43.31 - 43.31
43.86 - 43.82	769.5	43.31 - 43.30
43.82 - 43.80	768.9	43.30 - 43.30
43.80 - 43.78	768.3	43.30 - 43.33
43.78 - 43.79	767.7	43.33 - 43.33

The rise in boiling point observed in the last fraction was probably due to superheating. No correction was necessary for the exposed stem because the distilling flask with a long neck made especially for the purpose was used, which made it possible to surround the total column of mercury with the vapor of the alkyl halide. In correcting for the atmospheric pressure the value used was 0.041° per millimeter. The total amount of methyl iodide recovered in these ten fractions was 1772 grams out of the 3000 grams used. This is a very satisfactory yield for such a volatile substance. In order to decrease the loss due to the volatility of the methyl iodide, ice-water was continually run through the condenser by means of a fine lead coil of several turns surrounded by ice, and the receiving bottles were cooled by ice-water and fairly tightly stoppered with cotton. It was not usual for the boiling point to become constant at the very beginning of the distillation,

Observed B.pt.	Barometer Correction B.pt.	
43.80 - 43.80°	735.4 mm.	43.17 - 43.30°
43.81 - 43.80	736.8	43.18 - 43.30
43.82 - 43.81	737.8	43.30 - 43.18
43.81 - 43.81	738.3	43.18 - 43.18
43.80 - 43.81	771.3	43.31 - 43.31
43.81 - 43.80	770.8	43.31 - 43.31
43.80 - 43.82	738.5	43.31 - 43.30
43.81 - 43.80	738.6	43.30 - 43.30
43.80 - 43.78	738.1	43.30 - 43.28
43.78 - 43.78	737.7	43.28 - 43.28

The rise in boiling point observed in the last fraction was probably due to superheating. No correction was necessary for the exposed stem because the distilling flask with a long neck made especially for the purpose was used, which made it possible to surround the total column of mercury with the vapor of the alkyl halide. In correcting for the atmospheric pressure the value used was 0.041° per millimeter. The total amount of methyl iodide recovered in these ten fractions was 1773 grams out of the 3000 grams used. This is a very satisfactory yield for such a volatile substance. In order to decrease the loss due to the volatility of the methyl iodide, ice-water was continually run through the condenser by means of a nice lead coil of several turns surrounded by ice, and the receiving cottles were cooled by ice-water and fairly tightly stoppered with cotton. It was not used for the boiling point to cause comment at the very beginning of the distillation,

as did the above sample.

From another sample of methyl iodide from the same source which had been treated in a similar manner but without the special precautions taken for excluding moisture from all apparatus and for preventing the loss of methyl iodide, only about 1350 grams were obtained. This had a boiling point of 43.19 - 43.23°, most of which, however, came over at 43.30 - 43.33° which is identically the same boiling point obtained in the sample mentioned above. The lower yield was partly due to the fact that the methyl iodide was digested twice for nearly a whole day on a water bath in the presence of phosphorus pentoxide, and it was impossible to prevent entirely the escape of the vapor from the connections and also from the top of the condenser. It was afterwards found that this heating was entirely superfluous as a sample which simply stood over night with phosphorus pentoxide gave a very satisfactory boiling point.

Another sample from Hoffmann and Kruff, treated in a similar way but without the special precautions, and distilled with the mercury column exposed, gave the corrected boiling point of 43.15 - 43.19°. There is no doubt in the author's mind that this discrepancy is principally the result of errors in correcting the boiling point and that the sample was practically as good as those mentioned above.

One sample of good methyl iodide which had stood during the summer was distilled once from phosphorus pentoxide and then fractionated; it gave a large middle portion which boiled at 43.31 - 43.34°. Another sample of methyl iodide

as did the above sample.

From another sample of methyl iodide from the same source which had been treated in a similar manner but without the special precautions taken for excluding moisture from all apparatus and for preventing the loss of methyl iodide, only about 1000 grams were obtained. This had a boiling point of 41.18 - 41.23°, most of which, however, came over at 41.20 - 41.24° which is identically the same boiling point obtained in the sample mentioned above. The lower yield was partly due to the fact that the methyl iodide was digested twice for nearly a whole day on a water bath in the presence of phosphorus pentoxide, and it was impossible to prevent entirely the escape of the water from the connections and also from the top of the condenser. It was afterwards found that this boiling was entirely superfluous as a sample which simply stood over night with phosphorus pentoxide gave a very satisfactory boiling point.

Another sample from Hoffmann and Truff, treated in a similar way but without the special precautions, and distilled with the mercury column exposed, gave the corrected boiling point of 41.18 - 41.19°. There is no doubt in the author's mind that this discrepancy is principally the result of errors in correcting the boiling point and that the sample was practically as good as those mentioned above.

One sample of good methyl iodide which had stood during the summer was distilled once from phosphorus pentoxide and then fractionated; it gave a large middle portion which boiled at 41.21 - [illegible]. Another sample of methyl iodide

which was made in the laboratory by the method described by Robertson, gave a fraction boiling at 43.17 - 43.33°.

It would seem from the boiling points obtained that the methyl iodide used in the reactions was of especial purity. Nevertheless, it was not only a wise precaution but a point of great interest to determine the composition of such samples by analysis.

Analysis of Methyl Iodide. At first an attempt was made to use small glass bulbs which were filled with the sample, sealed, weighed, and then broken by means of a glass rod in an excess of a 2/N solution of sodium ethylate contained in a small flask, the latter being afterward corked and warmed at about 60°. After the reaction was complete the solution was acidified and the iodine was precipitated as silver iodide.

AgI obtained	AgI calculated	Per cent. error.
1.0336 gms.	1.0364 gms.	-0.3
3.1841 "	3.1938 "	-0.5

Either loss of alkyl halide occurred during the heating, or moisture was absorbed by the methyl iodide while the bulb was being filled.

Much more satisfactory results were obtained by using small weighing tubes with ground glass stoppers which were especially made for the purpose and held about two cubic centimeters. The alkyl halide could thus be weighed accurately and without loss. The weighing tube containing the alkyl halide was then placed in a regular Carius tube containing an excess of sodium ethylate, sealed, and heated a sufficient

which was made in the laboratory by the method [illegible] Robertson, gave a fraction boiling at 41.17 - 44.[illegible]°.

It would seem from the boiling points obtained that the methyl iodide used in the reactions was of especial purity. Nevertheless, it was not only a wise precaution but a point of great interest to determine the composition of such samples by analysis.

Analysis of Methyl Iodide. At first an attempt was made to use small glass bulbs which were filled with the sample, sealed, weighed, and then broken by means of a glass rod in an excess of a 5 % solution of sodium ethylate contained in a small flask, the latter being afterward corked and placed in about 60°. After the reaction was complete the solution was acidified and the iodide was precipitated as silver iodide.

AgI obtained	AgI calculated	Per cent. error
1.0[illegible] gms.	1.0[illegible] gms.	-0.5
0.1[illegible]	0.1[illegible]	-0.5

Either loss of alkyl halide occurred during the reaction; the moisture was absorbed by the methyl iodide while the bulb was being filled.

Much more satisfactory results were obtained by using small weighing tubes with ground glass stoppers which were especially made for the purpose and held about two cubic centimeters. The alkyl halide could thus be weighed accurately and without loss. The weighing tube containing the alkyl halide was then placed in a regular Carius tube containing an excess of sodium ethylate, sealed, and heated a sufficient

length of time in a water bath. It was necessary, of course, to mix the contents thoroughly before heating. The stopper in the little weighing tube was easily removed by warming the tube slightly and then shaking it gently. When the reaction was complete the contents of the tube were washed into a beaker, and then filtered into a calibrated flask, diluted to the mark and weighed. Each portion taken out for analysis was then weighed, since this procedure was much more accurate than the volumetric method.

Sample I.

AgI obtained	AgI calculated	Per cent. error.
2.0346 gms.	2.0327 gms.	+0.1
2.0336	2.0339	-0.014
1.9956	1.9953	+0.015

Sample II.

A

AgI obtained	AgI calculated	Per cent. error.
1.5890 gms.	1.5889 gms.	0.00
1.5886	1.5889	-0.02
1.5894	1.5898	-0.025

B

1.7233 gms.	1.7243 gms.	-0.05
1.7264	1.7280	-0.10
1.7271	1.7273	-0.012

C

1.5493 gms.	1.5500 gms.	-0.05
1.5489	1.5495	-0.04
1.5488	1.5499	-0.07

length of time in a water bath. It was necessary, of course, to mix the solution thoroughly before heating. The stopper in a little weighing tube was easily removed by warming the tube slightly and then smoking it gently. When the reaction was complete the contents of the tube were washed into a beaker, and then filtered into a calibrated flask, diluted to the mark and weighed. Each section taken out for analysis was then weighed, since this procedure was made more accurate than the volumetric method.

Sample I.

Ag I obtained	Ag I calculated	Per cent. error.
3.0240 gms.	3.0237 gms.	+0.1
3.0832	3.0838	-0.014
1.9958	1.9958	+0.015

Sample II.

A

Ag I obtained	Ag I calculated	Per cent. error.
1.5880 gms.	1.5889 gms.	0.00
1.5888	1.5889	-0.03
1.5894	1.5896	-0.036

B

1.7333 gms.	1.7343 gms.	-0.03
1.7384	1.7380	-0.10
1.7371	1.7373	-0.015

C

1.5600 gms.	1.5600 gms.	-0.06
1.5600	1.5600	-0.04
1.5600	1.5600	-0.07

In the above analyses Sample I and Sample II were taken from different samples of methyl iodide.

It is seen that we can easily make alkyl halides with a high degree of purity and that this method of analysis is very accurate.

Preparation of solutions for salt catalysis. The alcohol used contained from 0.03 - 0.04 per cent. of water. The preparation of this alcohol has been previously described by Roberteon as was also the regulation of the bath at 25°, and the mode of procedure used in determining the velocity constants at this temperature.

The solutions for the experiments on the salt effect were usually prepared by making a sodium ethylate solution having a strength slightly greater than that desired. The calculated number of cubic centimeters of the solution, say 90 - 95 c.c., were put into a 100 c.c. flask which already contained the amount of sodium iodide required, diluted to the mark, and then 10 c.c. of this was titrated to obtain the value of A. A very small excess of the ethylate solution was usually added to be sure that the resulting solution was not too dilute. If too concentrated, the calculated amount of alcohol was added; if this was more than a few tenths of one cubic centimeter, more sodium iodide was added as well. The amount of salt added in these cases was too small to introduce any appreciable error in the volume.

Calibration of the machine. Since methyl iodide is so very volatile it would be impossible to transfer the solution to the reaction flasks by the use of an ordinary pipette, without losing a large amount of the alkyl halide. A special ap-

In the above examples [illegible] it was taken from different samples of [illegible] iodide.

It is seen that [illegible] can easily [illegible] alkyl halides with a high degree of purity and that this method of analysis is very accurate.

Preparation of solutions for salt catalysis. The alcohol used contained from [illegible] - [illegible] per cent. of water. The preparation of this alcohol has been previously described by Robertson as was also the regulation of the path of [illegible], and the mode of procedure used in determining the velocity constants at this temperature.

The solutions for the experiments on the salt effect were usually prepared by taking a sodium ethylate solution having a strength slightly greater than that desired. The calculated number of cubic centimeters of the solution, say 20 - 50 c.c., were put into a 100 c.c. flask which already contained the amount of sodium iodide required, diluted to the mark, and then 10 c.c. of this was titrated to obtain the value of [illegible]. A very small excess of the ethylate solution was usually added to be sure that the [illegible] solution was not too dilute. If too concentrated, the calculated amount of alcohol was added, if this was [illegible] than a [illegible] of one cubic centimeter, more sodium iodide was added as well. The amount of salt added in these cases was too small to introduce any appreciable error in the volume.

Calibration of the pipettes. Since ethyl iodide is so very volatile it [illegible] impossible to measure the solution in the [illegible] [illegible] of the [illegible] pipette, [illegible] [illegible] [illegible] special ap-

paratus called the "machine" was devised to transfer these solutions with the least possible loss. This machine was described in detail by Robertson.

The machine pipette was first marked to deliver 10 c.c. of absolute alcohol at 20° and the volume obtained was 10.004 c.c., the error being less than 0.1 per cent. Since this pipette was to be used for alkyl halide solutions, the author wished to determine whether the same volume of methyl iodide solution would be obtained. The specific gravity of the methyl iodide solution was determined and successive portions of 10 c.c. each were then run out into the same small flasks used for reactions, and weighed. These flasks were closed by corks but it had been shown previously that the reaction mixture did not escape, and in this case it was found that these flasks containing the volatile methyl iodide solution could be weighed without loss. The volumes of N/2 and N/4 alkyl halide solutions obtained at 25° were 10.00, 9.997, 9.982, 9.993, 9.996, and 9.990 c.c. The average of these is 9.993 c.c. and was considered as sufficiently near to the desired volume. Although this difference is probably within the experimental error, yet it is quite possible that the alkyl halide solution is slightly more viscous and does not drain as readily.

When using this same machine at 0° the pipette was recalibrated with a methyl iodide solution at this temperature. The volumes obtained were 9.979, 9.981, 9.971, 9.975, and 9.974 c.c. the average being 9.976 c.c. In all of the work at 0° the solution was run out to a point on the pipette which would deliver exactly 10 c.c. at this temperature.

[illegible]

Determination of loss of alkyl halide. An investigation was also carried out to determine whether it was necessary to keep the tip of the delivery tube of the machine below the surface of the liquid in the reaction flask while introducing the alkyl halide solution.

AgI obtained	AgI calculated.	Strength of solution	Percentage error.	Position of tip
2.3483	2.3550	(100.3 o/o)	-0.38	Below surface of liquid.
2.3374	2.3550	"	-0.75	Just below neck of flask.
2.3330	2.3550	"	-0.90	Near top of neck.
2.3455	2.3550	"	-0.40	Just below neck.
2.3330	2.3550	"	-0.90	Half way down neck.

These figures show that it is certainly necessary to keep the tip well under the surface of the liquid.

A large number of determinations were also carried out to see whether the three tenths per cent. excess of methyl iodide ordinarily added was sufficient to make up for any loss of the alkyl halide during the preparation and transfer of the solution. While keeping the conditions the same as those used for studying the reactions, 10 c.c. of the solution was run into a small reaction flask containing a 50 per cent. alcoholic solution of silver nitrate. The results obtained are given in the tables below. The calculated values given for the silver iodide include the excess added which is given in the parenthesis under "Strength of solution".

[illegible]

[illegible] is necessary to keep the tip of the delivery tube, below the surface of the liquid in the reaction flask while introducing the dibyl halide solution.

Mgl. obtained	Mgl calculated.	Strength of solution	Percentage error.	Position of tip
[illegible]	[illegible]	(100.0 c.c.)	[illegible]	Below surface of liquid.
[illegible]	[illegible]	"	[illegible]	Just below neck of flask.
[illegible]	[illegible]	"	[illegible]	Near top of neck.
[illegible]	[illegible]	"	[illegible]	Just below neck.
[illegible]	[illegible]	"	[illegible]	Half way down neck.

These figures show that it is certainly necessary to keep the tip well under the surface of the liquid.

A large amount of determinations were also carried out to see whether the three tenths per cent. excess of [illegible] [illegible] [illegible] was sufficient to make up for any loss of the dibyl halide during the [illegible] transfer of the solution. While keeping the conditions the same as those used for [illegible] the reactions, 10 c.c. of the solution was run into a small reaction flask containing a 50 per cent. alcoholic solution of silver nitrate. The results obtained are given in the tables below. The calculated values given for the silver [illegible] [illegible] the [illegible] which is given in the parenthesis under "Strength of solution".

AgI obtained	AgI calculated	Strength of solution	Per cent. error.
3.3535 gms.	3.3550 gms.	(100.1o/o)	-0.06
3.3500	3.3550	(100.1 ")	-0.31
3.3424	3.3550	(100.1 ")	-0.11
3.3570	3.3630	(100.6 ")	-0.31
3.3533	3.3597	(100.5 ")	-0.27
1.1727	1.1775	(100.3 ")	-0.40
1.1713	1.1775	(100.3 ")	-0.53
			Average = -0.26

At 0°.

AgI obtained	AgI calculated	Strength of solution	Per cent. error.
1.1743*gms.	1.1799 gms.	(100.5c/o)	-0.47
1.1739*	1.1799	(100.5 ")	-0.60
1.1730*	1.1799	(100.5 ")	-0.60
3.3584	3.3598	(100.5 ")	-0.06
4.7279	4.7388	(100.7 ")	-0.02
3.3576	3.3631	(100.6 ")	-0.20
3.3583	3.3631	(100.6 ")	-0.16
3.3542	3.3598	(100.5 ")	-0.22
4.7057	4.7101	(100.3 ")	-0.09
3.3495	3.3598	(100.5 ")	-0.43
* Same solution			Average =-0.27

The average of the above analyses shows that the 0.3 per cent. excess of methyl iodide seems to be sufficient although there is considerable variation in the results. However, in a number of reactions 0.5 per cent. excess was added.

AgI obtained	AgI calculated	Strength of solution	Per cent. error.
[illegible] gms.	[illegible] gms.	(100.1c/c)	-0.08
[illegible]	[illegible]	(100.1 ")	-0.31
[illegible]	[illegible]	(100.1 ")	-0.11
[illegible]	[illegible]	(100.3 ")	-0.31
[illegible]	[illegible]	(100.5 ")	-0.37
1.1737	1.1778	(100.3 ")	-0.40
1.1713	1.1778	(100.5 ")	-0.08
			Average = -0.[illegible]

At 0°.

AgI obtained	AgI calculated	Strength of solution	Per cent. error.
1.1743*gms.	1.1738 gms.	(100.5c/c)	-0.47
1.1732*	1.1738	(100.5 ")	-0.[illegible]
1.1730*	1.1738	(100.5 ")	-0.80
[illegible]	[illegible]	(100.5 ")	-0.08
[illegible]	[illegible]	(100.7 ")	-0.05
[illegible]	[illegible]	(100.6 ")	-0.30
[illegible]	[illegible]	(100.6 ")	-0.12
[illegible]	[illegible]	(100.5 ")	-0.[illegible]
4.7007	[illegible]	(100.5 ")	-0.08
[illegible]	[illegible]	(100.5 ")	-0.49
* Same solution			Average = -0.[illegible]

The average of the above analyses shows that the 0.5 per cent. excess of methyl iodide works to be sufficient although there is considerable variation in the results. However, in a number of reactions 0.5 per cent. excess was added.

Reaction velocities at 0°. For the study of the velocity of the reaction between methyl iodide, sodium, lithium, and potassium ethylates at 0° an ice bath was used which gave very satisfactory results. This consisted of a copper bath ten inches deep and fourteen inches in diameter which was tinned on the inside, and placed in a wooden box containing lamb's wool. The bottom was protected with a thick felt pad about one inch thick, and the top, by a tightly fitting metal cover over which were placed several pads of felt and wool. The metal cover was made in two pieces, one of which was removed when it was necessary to take out the flask, start the reaction, etc. The bath as set up ready for use is shown in the diagram on page 64. Special attention is called to the stirring device. The motor is supported by an iron framework which is bolted firmly to the wall to prevent vibration. Motion is imparted to the propellor shaft by a friction pulley, by means of which the speed can be easily controlled.

Tests with a Beckmann thermometer showed that all parts of the bath remained within a few thousandths of a degree of zero. The ethylate solutions were made up at 0°, and transferred at this temperature into the reaction flasks by surrounding the pipette with a jacket containing cracked ice and water. In beginning this work the jacket of the machine pipette was filled only once or twice with ice water during the seven or eight minutes required for running out all of the alkyl halide solution. The reaction flask containing the ethylate solution had to be lifted from the ice bath in order to keep

Resulting equilibrium at T°. For the study of the relationship of the reaction between acetyl iodide, acetone, iodine, and hydrogen chloride at 0° an ice bath was used which gave very satisfactory results. This consisted of a copper tank six inches deep and fourteen inches in diameter which was filled on the inside, and placed in a wooden box containing fine wood. The bottom was protected with a thick felt pad about one inch thick, and the top, by a tightly fitting metal cover over which were placed several pads of felt and wood. The metal cover was made in two pieces one of which was removed when it was necessary to take out the flask, after the reaction, etc. The bath was set in temp for use in which in the [illegible] to use 0°. Special attention is called to the stirring device. The motor is supported by an iron framework which is bolted firmly to the wall to prevent vibration. Motion is imparted to the propeller shaft by a friction pulley, by means of which the speed can be [illegible] varied.

Tests with a Beckmann thermometer showed that at [illegible] or low well regulated within a [illegible] thousandths of a degree [illegible]. The adjusted solutions were made up at 0°, and [illegible] there at this temperature in order to prevent timely by [illegible] the stirrer with a jacket containing cracked ice and water. In beginning this work the [illegible] of the [illegible] [illegible] [illegible] of [illegible] [illegible] [illegible]

the delivery tip of the machine under the surface of the liquid in the reaction flask. The tube was then shaken by inverting it a few times, and then put back into the bath. Although this process required only one minute for each tube, test with a thermometer showed that the temperature had risen several degrees, and that some better method had to be devised. The possibility of mixing the solution under ice water was suggested, but as this method would have required new apparatus, the following method was tried with very satisfactory results. Ice water from the bath was run continuously through the jacket of the machine by means of a pump run by a small electric motor. Although the exposed circulation was made as short as possible, the temperature of the water returning to the bath had risen several degrees. Even when this current of water was returned to the bath in the vicinity of the thermometer, no change in the temperature could be detected unless the water played directly upon the thermometer. In that part of the bath which contained the reaction flasks, no change in temperature could be detected. The delivery tube of the machine and all exposed connecting tubes were protected by several layers of binding tape, and that liquid in the most exposed part of the delivery tip was discarded just before each 10 c.c. portion was run out. The reaction flask containing the ethylate solution was lifted from the bath in a beaker containing cracked ice and water, and after the alkyl halide solution had been transferred to it, the flask was returned to the bath as rapidly as possible. Tests made with the thermometer showed that by this method the temperature was kept below 0.5° , and the zero point was quickly

the delivery tip of the machine under the surface of the liquid in the reaction flask. The tube was then cooled by inverting it a few times, and then put back into the bath. Although this process required only one minute for each pulse, test with a thermometer showed that the temperature had risen several degrees, and that some better method had to be devised. The possibility of mixing the solution under ice water was suggested, but as this method would have required new apparatus, the following method was tried with very satisfactory results. Ice water from the bath was run continuously through the jacket of the machine by means of a pump run by a small electric motor. Although the exposed circulation was made as short as possible, the temperature of the water returning to the bath had risen several degrees. Even when this current of water was returned to the bath in the vicinity of the thermometer, no change in the temperature could be detected unless the water played directly upon the thermometer. In that part of the bath which contained the reaction flasks, no change in temperature could be detected. The delivery tube of the machine and all exposed connecting tubes were protected by several layers of cooling tube, and the liquid in the most exposed part of the delivery tip was [illegible] just before each 17 c.c. portion was run out. The reaction flask containing the chloride solution was lifted from the bath in a beaker containing crushed ice and water and after the alkyl halide solution had been transferred to it, the flask was returned to the bath as rapidly as possible. Tests made with the [illegible] showed that by this method the temperature was [illegible] [illegible] [illegible] [illegible] [illegible]

reached by shaking the flask two minutes in the bath. For the work with the N/16 and N/32 solutions 40 c.c. portions were used instead of the usual 30 c.c., and the solutions were mixed by inverting and shaking the flasks under the ice water. The corks were protected by "rubber fingers" over the necks of the flasks. A rise in the temperature of even several tenths of a degree for one minute would have but little effect on the constants, especially those for the dilute solutions for which the time periods were so long.

Lithium Ethylate and Methyl Iodide at 0°C.

Table I

0.5 N Lithium Ethylate and

0.5 Methyl Iodide at 0°C.

A = 9.98

t	x	K_v
180	1.783	0.001207
240	3.236	0.001196
300	3.642	0.001200
382	3.156	0.001210
1378	5.946	0.001153
1667	6.580	0.001161

Average = 0.001188

K_n = 0.002381

K_n* = 0.002411

Table II

0.5 N Lithium Ethylate and

0.5 N Methyl Iodide at 0°C.

A = 9.98

t	x	K_v
205	2.016	0.001234
266	2.448	0.001233
347	2.972	0.001232
1353	6.120	0.001172
1430	6.264	0.001180

Average = 0.001206

K_n = 0.002417

K_n* = 0.002435

Table III

0.5 N Lithium Ethylate and

1.0 N Methyl Iodide at 0°C.

A = 10.00 B = 20.00

t	x	K_v
180	3.318	0.001233
256	4.240	0.001224
330	4.960	0.001214
434	5.690	0.001195
520	6.304	0.001186

Average = 0.001210

K_n = 0.002430

Table IV

0.25 N Lithium Ethylate and

0.5 N Methyl Iodide at 0°C.

A = 10.01 B = 20.00

t	x	K_v
142	1.722	0.0006967
197	2.246	0.0006863
259	2.790	0.0006826
318	3.250	0.0006748
348	3.470	0.0006739

Average = 0.0006828

K_n = 0.002728

* If last two values of K_v are omitted.

Table I

0.2 Linear Regression and

0.4 Normal Deviate at 95%.

$\lambda = 0.05$

Y	X	$\hat{Y}$
300	1.700	0.000000
320	1.800	0.000000
350	1.900	0.000000
380	2.000	0.000000
410	2.100	0.000000
440	2.200	0.000000
470	2.300	0.000000
500	2.400	0.000000

Average = 0.000000

$\hat{Y}_{av}$ = 0.000000

$\Sigma \hat{Y}_{av}$ = 0.000000

Table II

0.2 Linear Regression and

0.4 Normal Deviate at 95%.

$\lambda = 0.05$

Y	X	$\hat{Y}$
300	1.700	0.000000
320	1.800	0.000000
350	1.900	0.000000
380	2.000	0.000000
410	2.100	0.000000
440	2.200	0.000000
470	2.300	0.000000
500	2.400	0.000000

Average = 0.000000

$\hat{Y}_{av}$ = 0.000000

$\Sigma \hat{Y}_{av}$ = 0.000000

Table III

0.2 Linear Regression and

0.4 Normal Deviate at 95%.

$\lambda = 0.05$ $\lambda = 0.01$

Y	X	$\hat{Y}$
300	1.700	0.000000
320	1.800	0.000000
350	1.900	0.000000
380	2.000	0.000000
410	2.100	0.000000
440	2.200	0.000000
470	2.300	0.000000
500	2.400	0.000000

Average = 0.000000

$\hat{Y}_{av}$ = 0.000000

$\Sigma \hat{Y}_{av}$ = 0.000000

Table IV

0.2 Linear Regression and

0.4 Normal Deviate at 95%.

$\lambda = 0.05$ $\lambda = 0.01$

Y	X	$\hat{Y}$
300	1.700	0.000000
320	1.800	0.000000
350	1.900	0.000000
380	2.000	0.000000
410	2.100	0.000000
440	2.200	0.000000
470	2.300	0.000000
500	2.400	0.000000

Average = 0.000000

$\hat{Y}_{av}$ = 0.000000

$\Sigma \hat{Y}_{av}$ = 0.000000

* If less than one values of $\hat{Y}$, not printed.

Table V

0.25 N Lithium Ethylate and

0.5 N Methyl Iodide at 0°C.

A = 10.03 B = 30.00

t	x	K_v
344	3.456	0.0006805
432	3.976	0.0006730
502	4.460	0.0006730
1480	7.613	0.0006420
1606	7.830	0.0006367

Average = 0.0006567

K_n = 0.003632

K_n* = 0.003696

Table VI

0.25 N Lithium Ethylate and

1.0 N Methyl Iodide at 0°C.

A = 10.03 B = 40.00

t	x	K_v
187	3.840	0.0006831
230	4.444	0.0006803
300	5.256	0.0006714
340	5.656	0.0006670
390	6.104	0.0006630
440	6.500	0.0006597

Average = 0.0006707

K_n = 0.003678

Table VII

0.125 N Lithium Ethylate and

0.25 N Methyl Iodide at 0°C.

A = 10.04 B = 20.00

t	x	K_v
1016	4.832	0.0003767
1077	4.993	0.0003746
1140	5.144	0.0003719
1201	5.304	0.0003718
1277	5.488	0.0003710
1347	5.698	0.0003712

Average = 0.0003729

K_n = 0.003971

Table VIII

0.125 N Lithium Ethylate and

0.1373 N Methyl Iodide at 0°C.

A = 10.00 B = 10.18

t	x	K_v
1098	2.960	0.0003745
1194	3.136	0.0003742
1289	3.296	0.0003730
1428	3.636	0.0003743
1509	3.656	0.0003732
3619	4.993	0.0003705

Average = 0.0003733

K_n = 0.003986

* If last two values of K_v are omitted.

TABLE I

0.25 I Sibson Polytope and

0.0 A Smooth Cousin at $0^{\circ}C$.

$\Sigma = 20.00 \quad \Sigma = 20.00$

Σ	Δ	Δ^2
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Average = [illegible]

$\Delta^2_{\Sigma} = [illegible]$

$\Delta^2_{\Delta} = [illegible]$

TABLE II

[illegible] I Sibson Tetrahedron and

[illegible] A Smooth Cousin at $0^{\circ}C$.

$\Sigma = [illegible] \quad \Sigma = [illegible]$

Σ	Δ	Δ^2
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Average = [illegible]

$\Delta^2_{\Sigma} = [illegible]$

TABLE III

[illegible] I Sibson Tetrahedron and

[illegible] A Smooth Cousin at $0^{\circ}C$.

$\Sigma = [illegible] \quad \Sigma = [illegible]$

Σ	Δ	Δ^2
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Average = [illegible]

$\Delta^2_{\Sigma} = [illegible]$

TABLE IV

[illegible] I Sibson Tetrahedron and

[illegible] A Smooth Cousin at $0^{\circ}C$.

$\Sigma = [illegible] \quad \Sigma = [illegible]$

Σ	Δ	Δ^2
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Average = [illegible]

$\Delta^2_{\Sigma} = [illegible]$

* [illegible] [illegible] [illegible] [illegible] [illegible].

Table IX

0.0625 N Lithium Ethylate and

0.35 N Methyl Iodide at 0°C.

A = 9.99 B = 40.00

t	x	K_v
585	3.706	0.0002084
657	4.030	0.0002078
830	4.758	0.0002085
905	4.994	0.0002058
1034	5.433	0.0002050
3108	7.750	0.0002031

Average = 0.0002063

K_n = 0.003304

Table X

0.0625 N Lithium Ethylate and

0.1289 N Methyl Iodide at 0°C.

A = 10.01 B = 30.63

t	x	K_v
976	3.198	0.0002144
1066	3.394	0.0002135
1134	3.570	0.0002140
1370	3.858	0.0002130
1378	4.086	0.0002132
2514	6.058	0.0002234
2777	6.154	0.0002088

Average = 0.0002142

K_n = 0.003433

Table XI

0.0625 N Lithium Ethylate and

0.35 N Methyl Iodide at 0°C.

A=10.00 B =40.00

t	x	K_v
567	3.640	0.0002098
612	3.840	0.0002088
680	4.140	0.0002083
780	4.540	0.0002070
900	5.008	0.0002077
1020	5.416	0.0002072

Average = 0.0002081

K_n = 0.003330

Table XII

0.0625 N Lithium Ethylate and

0.35 N Methyl Iodide at 0°C.

A = 10.02 B = 40.00

t	x	K_v
1045	5.444	0.0002036
1135	5.692	0.0002019
1202	5.934	0.0002041
1336	6.244	0.0002031
1496	6.638	0.0002014
2480	8.212	0.0001997

Average = 0.0002023

K_n = 0.003231

TABLE 1

Cases 1 Leading Coefficient and Single Root at $t^{(1)}$.

$(\alpha = 0.01,\ \beta = 0.01)$

t	x	$t_c^{(1)}$
[illegible]	0.[illegible]	0.[illegible]
[illegible]	0.[illegible]	0.[illegible]
[illegible]	0.[illegible]	0.[illegible]
[illegible]	0.[illegible]	0.[illegible]
[illegible]	0.[illegible]	0.[illegible]
[illegible]	0.[illegible]	0.[illegible]
[illegible]	0.[illegible]	0.[illegible]
[illegible]	0.[illegible]	0.[illegible]

Average = 0.[illegible]

$t_c^{(1)}$ = 0.[illegible]

TABLE 2

Cases 1 Leading Coefficient and Single Root at $t^{(2)}$.

$(\alpha = 0.01,\ \beta = 0.01)$

t	x	$t_c^{(2)}$
[illegible]	0.[illegible]	0.[illegible]
[illegible]	0.[illegible]	0.[illegible]
[illegible]	0.[illegible]	0.[illegible]
[illegible]	0.[illegible]	0.[illegible]
[illegible]	0.[illegible]	0.[illegible]
[illegible]	0.[illegible]	0.[illegible]
[illegible]	0.[illegible]	0.[illegible]
[illegible]	0.[illegible]	0.[illegible]

Average = 0.[illegible]

$t_c^{(2)}$ = 0.[illegible]

TABLE 3

Cases 1 Leading Coefficient and Single Root at $t^{(1)}$.

$(\alpha = 0.05,\ \beta = 0.05)$

t	x	$t_c^{(1)}$
[illegible]	0.[illegible]	0.[illegible]
[illegible]	0.[illegible]	0.[illegible]
[illegible]	0.[illegible]	0.[illegible]
[illegible]	0.[illegible]	0.[illegible]
[illegible]	0.[illegible]	0.[illegible]
[illegible]	0.[illegible]	0.[illegible]
[illegible]	0.[illegible]	0.[illegible]
[illegible]	0.[illegible]	0.[illegible]

Average = 0.[illegible]

$t_c^{(1)}$ = 0.[illegible]

TABLE 4

Cases 1 Leading Coefficient and Single Root at $t^{(2)}$.

$(\alpha = 0.05,\ \beta = 0.05)$

t	x	$t_c^{(2)}$
[illegible]	0.[illegible]	0.[illegible]
[illegible]	0.[illegible]	0.[illegible]
[illegible]	0.[illegible]	0.[illegible]
[illegible]	0.[illegible]	0.[illegible]
[illegible]	0.[illegible]	0.[illegible]
[illegible]	0.[illegible]	0.[illegible]
[illegible]	0.[illegible]	0.[illegible]
[illegible]	0.[illegible]	0.[illegible]

Average = 0.[illegible]

$t_c^{(2)}$ = 0.[illegible]

Table XIII

0.03135 N Lithium Ethylate and

0.35 N Methyl Iodide at 0°C.

A = 10.03 B = 80.00

t	x	K_v
570	4.030	0.0001163
630	4.326	0.0001157
690	4.590	0.0001148
780	4.934	0.0001156
890	5.430	0.0001143
1080	6.070	0.0001139

Average = 0.0001149

K_n = 0.003665

Table XIV

0.03135 N Lithium Ethylate and

0.135 N Methyl Iodide at 0°C.

A = 10.00 B = 40.00

t	x	K_v
1067	3.752	0.0001161
1136	3.880	0.0001141
1287	4.318	0.0001166
1463	4.634	0.0001134
2433	6.388	0.0001138
3896	6.880	0.0001136

Average = 0.0001143

K_n = 0.003657

Table XV

0.03135 N Lithium Ethylate and

0.35 N Methyl Iodide at 0°C.

A = 10.00 B = 80.00

t	x	K_v
561	3.840	0.0001108
647	4.328	0.0001129
816	5.000	0.0001100
898	5.296	0.0001090
983	5.664	0.0001107
1053	5.928	0.0001114
2086	8.168	0.0001087

Average = 0.0001105

K_n = 0.003536

TABLE III

Table 3 Sample Functions and Sample Values at t_0.

$x = 1/2(\omega_1 - \omega_2)$ $\quad y = 1/2(\omega_1 + \omega_2)$

x	y	ξ^0
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Average = [illegible]

σ_0^2 = [illegible]

TABLE IV

Table 4 Sample Functions and Sample Values at t_0.

$x = 1/2(\omega_1 - \omega_2)$ $\quad y = 1/2(\omega_1 + \omega_2)$

x	y	ξ^0
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Average = [illegible]

σ_0^2 = [illegible]

TABLE V

Table 5 Sample Functions and Sample Values at t_0.

$x = 1/2(\omega_1 - \omega_2)$ $\quad y = 1/2(\omega_1 + \omega_2)$

x	y	ξ^0
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Average = [illegible]

σ_0^2 = [illegible]

Table XVI

Summary of Lithium Ethylate and Methyl Iodide at 0°C.

V	K_n	Average K_n
2	0.002430	
	0.002381	
	(0.002411)	
	0.002417	0.002406
	(0.002435)	(0.002419)
4	0.002728	
	0.002678	
	0.002663	0.002690
	(0.002696)	(0.002700)
8	0.002971	
	0.002986	0.002978
16	0.003304	
	0.003423	
	0.003330	
	0.003331	0.003322
32	0.003665	
	0.003657	
	0.003536	0.003619

Values in parenthesis under K_n refer to starred values under tables
average K_n in parenthesis, only to the starred values in these tabl

Table XVII

Lithium Ethylate and Methyl Iodide at 0°C.

V	α	1 - α	K_n found a	K_n found b	K_n calculated a	K_n calculated b	Per cent.e a	
2	0.144	0.856	0.002406	0.002419	0.002440	0.002450	-1.40	-1
4	0.230	0.780	0.002690	0.002700	0.002690	0.002697	0.0	+0
8	0.312	0.688	0.002978	0.002978	0.002991	0.002994	-0.43	-0
16	0.409	0.591	0.003322	0.003322	0.003310	0.003308	+0.36	+0
32	0.519	0.481	0.003619	0.003619	0.003668	0.003662	-1.30	-1

Values under "b" are calculated on values of K_n in parenthesis.

Table XVIII

K_i and K_m for Lithium Ethylate and Methyl Iodide at 0°C.

V	K_i		K_m	
	a	b	a	b
2 : 4	0.005590	0.005569	0.001872	0.001891
2 : 8	0.005317	0.005263	0.001918	0.001943
2 : 16	0.005360	0.005331	0.001911	0.001931
2 : 32	0.005174	0.005157	0.001943	0.001960
4 : 8	0.005134	0.005060	0.002001	0.002035
4 : 16	0.005297	0.005364	0.001955	0.001977
4 : 32	0.005115	0.005098	0.002006	0.002024
8 : 16	0.005411	0.005411	0.001875	0.001875
8 : 32	0.005109	0.005109	0.002013	0.002013
16 : 32	0.004932	0.004932	0.002214	0.002314
Average =	0.005243	0.005218	0.001971	0.001986

Values under "b" are calculated from values of Average K_n in parenthesis.

TABLE XXIII

σ_1 and σ_2 for various functions and their ratios, using $\Delta t = 0.01$.

t	σ_1	σ_2
0 : 0	0.00000 0.00000	0.00000 0.00000
0 : 8	0.00000 0.00000	0.00000 0.00000
0 : 16	0.00000 0.00000	0.00000 0.00000
0 : 24	0.00000 0.00000	0.00000 0.00000
0 : 0	0.00000 0.00000	0.00000 0.00000
0 : 16	0.00000 0.00000	0.00000 0.00000
0 : 32	0.00000 0.00000	0.00000 0.00000
0 : 32	0.00000 0.00000	0.00000 0.00000
0 : 64	0.00000 0.00000	0.00000 0.00000
0 : 96	0.00000 0.00000	0.00000 0.00000

Average = 0.00000 0.00000 0.00000 0.00000

Entry under "0" has denominator zero because of zero in σ_1 or σ_2 or both.

Sodium Ethylate and Methyl Iodide at 0°C.

Table XIX

1.0 N Sodium Ethylate and

1.0 N Methyl Iodide at 0°C.

A = 9.97

t	x	K_v
150	3.330	0.003343
180	3.733	0.003325
210	4.088	0.003310
240	4.400	0.003291
1260	8.000	0.003233
1421	8.193	0.003244

Average = 0.003289

K_n = 0.003299

Table XX

1.0 N Sodium Ethylate and

1.0 N Methyl Iodide at 0°C.

A = 10.03

t	x	K_v
120	2.857	0.003319
150	3.319	0.003297
184	3.778	0.003284
197	3.923	0.003259
230	4.218	0.003299
1168	7.904	0.003183

Average = 0.003274

K_n = 0.003264

Table XXI

0.5 N Sodium Ethylate and

0.5 N Methyl Iodide at 0°C.

A = 10.00

t	x	K_v
150	2.058	0.001728
180	2.342	0.001700
210	2.634	0.001703
240	2.896	0.001698
2728	8.200	0.001670

Average = 0.001700

K_n = 0.003400

Table XXII

0.5 N Sodium Ethylate and

0.5 N Methyl Iodide at 0°C.

A = 10.03

t	x	K_v
180	2.372	0.001723
200	2.556	0.001713
230	2.842	0.001731
264	3.122	0.001714
290	3.342	0.001735
1230	6.770	0.001693

Average = 0.001715

K_n = 0.003430

Table (1)

(.0.2 Random Variables and

0.0 Sample Values of $f(t)$.

$t = 20.00$

f	x	f^2
100	0.000	0.000000
200	0.000	0.000000
300	0.000	0.000000
400	0.000	0.000000
500	0.000	0.000000
600	0.000	0.000000
700	0.000	0.000000
800	0.000	0.000000
900	0.000	0.000000
1000	0.000	0.000000

Average = 0.000000

$\overline{f^2}$ = 0.000000

Table (2)

(.0.2 Random Variables and

0.0 Sample Values of $f(t)$.

$t = 30.00$

f	x	f^2
100	0.000	0.000000
200	0.000	0.000000
300	0.000	0.000000
400	0.000	0.000000
500	0.000	0.000000
600	0.000	0.000000
700	0.000	0.000000
800	0.000	0.000000
900	0.000	0.000000
1000	0.000	0.000000

Average = 0.000000

$\overline{f^2}$ = 0.000000

Table (3)

(.0.2 Random Variables and

0.0 Sample Values of $f(t)$.

$t = 40.00$

f	x	f^2
100	0.000	0.000000
200	0.000	0.000000
300	0.000	0.000000
400	0.000	0.000000
500	0.000	0.000000
600	0.000	0.000000
700	0.000	0.000000
800	0.000	0.000000
900	0.000	0.000000
1000	0.000	0.000000

Average = 0.000000

$\overline{f^2}$ = 0.000000

Table (4)

(.0.2 Random Variables and

0.0 Sample Values of $f(t)$.

$t = 50.00$

f	x	f^2
100	0.000	0.000000
200	0.000	0.000000
300	0.000	0.000000
400	0.000	0.000000
500	0.000	0.000000
600	0.000	0.000000
700	0.000	0.000000
800	0.000	0.000000
900	0.000	0.000000
1000	0.000	0.000000

Average = 0.000000

$\overline{f^2}$ = 0.000000

Table XXIII

0.5 N Sodium Ethylate and

1.0 N Methyl Iodide at 0°C.

A = 9.98 B = 20.00

t	x	K_v
100	2.782	0.001762
210	4.686	0.001740
260	5.350	0.001750
300	5.764	0.001732
364	6.366	0.001731
430	6.862	0.001731

Average = 0.001739

K_n = 0.003485

Table XXIV

0.25 N Sodium Ethylate and

0.50 N Methyl Iodide at 0°C.

A = 10.00 B = 20.00

t	x	K_v
180	2.680	0.0009337
200	2.880	0.0009207
240	3.320	0.0009245
270	3.592	0.0009148
300	3.864	0.0009121
330	4.152	0.0009203
1270	8.120	0.0009056

Average = 0.0009188

K_n = 0.003679

Table XXV

0.25 N Sodium Ethylate and

0.25 N Methyl Iodide at 0°C.

A = 10.00

t	x	K_v
180	1.400	0.0009044
210	1.608	0.0009126
250	1.840	0.0009020
280	2.020	0.0009042
301	2.132	0.0009003
333	2.328	0.0009112
1280	5.360	0.0009025

Average = 0.0009053

K_n = 0.003621

Table XXVI

0.125 N Sodium Ethylate and

0.25 N Methyl Iodide at 0°C.

A = 10.00 B = 20.00

t	x	K_v
260	2.088	0.0004765
280	2.216	0.0004751
300	2.168	0.0004806
1232	6.160	0.0004779
1326	6.384	0.0004771
1409	6.600	0.0004812

Average = 0.0004781

K_n = 0.003825

Table 1(1)

0.02 2 radian frequency use

0.20 2 energy levels at $\zeta^{(1)}$.

$\lambda = 1,0,00$ $\lambda = 2,0,00$

$\zeta^{(1)}$	ζ	ζ
0.000000	1.000	100
0.000000	1.000	200
0.000000	1.000	300
0.000000	1.000	400
0.000000	1.000	500
0.000000	1.000	600
0.000000	1.000	700
0.000000	1.000	800
0.000000	1.000	900
0.000000	1.000	1000

Energy = 0.000000

ζ_0 = 0.000000

Table 1(2)

0.02 2 radian frequency use

0.20 2 energy levels at $\zeta^{(1)}$.

$\lambda = 1,0,00$ $\lambda = 2,0,00$

$\zeta^{(1)}$	ζ	ζ
0.000000	1.000	100
0.000000	1.000	200
0.000000	1.000	300
0.000000	1.000	400
0.000000	1.000	500
0.000000	1.000	600
0.000000	1.000	700
0.000000	1.000	800
0.000000	1.000	900
0.000000	1.000	1000

Energy = 0.000000

ζ_0 = 0.000000

Table 1(3)

0.02 2 radian frequency use

0.20 2 energy levels at $\zeta^{(1)}$.

$\lambda = 1,0,00$ $\lambda = 2,0,00$

$\zeta^{(1)}$	ζ	ζ
0.000000	1.000	100
0.000000	1.000	200
0.000000	1.000	300
0.000000	1.000	400
0.000000	1.000	500
0.000000	1.000	600
0.000000	1.000	700
0.000000	1.000	800
0.000000	1.000	900
0.000000	1.000	1000

Energy = 0.000000

ζ_0 = 0.000000

Table 1(4)

0.02 2 radian frequency use

0.20 2 energy levels at $\zeta^{(1)}$.

$\lambda = 1,0,00$ $\lambda = 2,0,00$

$\zeta^{(1)}$	ζ	ζ
0.000000	1.000	100
0.000000	1.000	200
0.000000	1.000	300
0.000000	1.000	400
0.000000	1.000	500
0.000000	1.000	600
0.000000	1.000	700
0.000000	1.000	800
0.000000	1.000	900
0.000000	1.000	1000

Energy = 0.000000

ζ_0 = 0.000000

Table XXVII

0.125 N Sodium Ethylate and

0.25 N Methyl Iodide at 0°C.

A = 10.00 B = 20.00

t	x	K_v
240	1.988	0.0004813
300	2.384	0.0004816
1275	6.288	0.0004811
1360	6.480	0.0004797
1420	6.608	0.0004785
1640	7.088	0.0004852

Average = 0.0004817

K_n = 0.003854

Table XXVIII

0.0625 N Sodium Ethylate and

0.25 N Methyl Iodide at 0°C.

A = 9.96 B = 40.00

t	x	K_v
988	5.824	0.0002420
1110	6.192	0.0002400
1180	6.480	0.0002457
1365	6.752	0.0002483
1340	6.856	0.0002419
1424	7.112	0.0002458

Average = 0.0002440

K_n = 0.003919

Table XXIX

0.0625 N Sodium Ethylate and

0.25 N Methyl Iodide at 0°C.

A = 10.02 B = 40.00

t	x	K_v
360	2.900	0.0002475
390	3.140	0.0002520
420	3.340	0.0002532
1530	7.396	0.0002479
1620	7.572	0.0002473

Average = 0.0002496

K_n = 0.003985

Table XXX

0.0625 N Sodium Ethylate and

0.25 N Methyl Iodide at 0°C.

A = 10.01 B = 40.00

t	x	K_v
1106	6.418	0.0002565
1180	6.632	0.0002552
1270	6.830	0.0002521
1350	7.070	0.0002548
1447	7.278	0.0002531

Average = 0.0002543

K_n = 0.004063

TABLE [illegible]

[illegible] 3 Medium Temperature and [illegible] 2 Energy Inputs at C_p^*.

$t = [illegible]$ $\Delta = [illegible]$

t	Δ	C_p^*
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Average = [illegible]

C_p^* = [illegible]

TABLE [illegible]

[illegible] 3 Medium Temperature and [illegible] 2 Energy Inputs at C_p^*.

$t = [illegible]$ $\Delta = [illegible]$

t	Δ	C_p^*
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Average = [illegible]

C_p^* = [illegible]

TABLE [illegible]

[illegible] 3 Medium Temperature and [illegible] 2 Energy Inputs at C_p^*.

$t = [illegible]$ $\Delta = [illegible]$

t	Δ	C_p^*
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Average = [illegible]

C_p^* = [illegible]

TABLE [illegible]

[illegible] 3 Medium Temperature and [illegible] 2 Energy Inputs at C_p^*.

$t = [illegible]$ $\Delta = [illegible]$

t	Δ	C_p^*
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Average = [illegible]

C_p^* = [illegible]

Table XXXI

0.0625 N Sodium Ethylate and

0.25 N Methyl Iodide at 0°C.

A = 10.00 B = 40.00

t	x	K_v
857	5.520	0.0002544
908	5.720	0.0002548
1031	6.160	0.0002552

Average = 0.0002548

K_n = 0.004077

Table XXXII

0.03125 N Sodium Ethylate and

0.25 N Methyl Iodide at 0°C.

A = 10.01 B = 80.00

t	x	K_v
673	4.970	0.0001331
751	5.338	0.0001319
821	5.562	0.0001287
899	5.874	0.0001284
966	6.314	0.0001353
1095	6.714	0.0001337

Average = 0.0001317

K_n = 0.004212

Table XXXIII

0.03125 N Sodium Ethylate and

0.25 N Methyl Iodide at 0°C.

A = 10.02 B = 80.00

t	x	K_v
220	2.032	0.0001305*
270	2.428	0.0001308
300	2.660	0.0001310
1337	7.180	0.0001258
1493	7.644	0.0001283

Average = 0.0001293

K_n = 0.004130

* A = 10.12

Table XXXIV

0.03125 N Sodium Ethylate and

0.125 N Methyl Iodide at 0°C.

A = 10.02 B = 40.00

t	x	K_v
1462	5.124	0.0001334
1670	5.524	0.0001306
1832	5.804	0.0001296
3020	7.476	0.0001288

Average = 0.0001304

K_n = 0.004165

Table [illegible]

[illegible] a Spring Finishing and [illegible] Spring Index of [illegible].

$d = 10.00$ $D = 80.00$

F	x	δ^2
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Average = [illegible]

δ^2 = [illegible]

Table [illegible]

[illegible] a Spring Finishing and [illegible] Spring Index of [illegible].

$d = 10.00$ $D = 80.00$

F	x	δ^2
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Average = [illegible]

δ^2 = [illegible]

Table [illegible]

[illegible] a Spring Finishing and [illegible] Spring Index of [illegible].

$d = 10.00$ $D = 80.00$

F	x	δ^2
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Average = [illegible]

δ^2 = [illegible]

Table [illegible]

[illegible] a Spring Finishing and [illegible] Spring Index of [illegible].

$d = 10.00$ $D = 80.00$

F	x	δ^2
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Average = [illegible]

δ^2 = [illegible]

$d = 10.00$

Table XXXV

Summary of Sodium Ethylate and Methyl Iodide at 0°C.

V	K_n	Average K_n
1	0.003399	
	0.003364	0.003381
2	0.003400	
	0.003430	
	0.003485	0.003435
4	0.003679	
	0.003631	0.003650
8	0.003835	
	0.003854	0.003840
16	0.003919	
	0.003985	
	0.004063	
	0.004077	0.004011
32	0.004212	
	0.004130	0.004169
	0.004165	

Table XXXVI

Sodium Ethylate and Methyl Iodide at 0°C.

V	α	$1 - \alpha$	K_n found	K_n calculated	Per cent. error
1	0.136	0.864	0.003381	0.003382	-0.03
2	0.237	0.763	0.003435	0.003466	-0.90
4	0.335	0.665	0.003650	0.003645	+0.13
8	0.435	0.565	0.003840	0.003828	+0.31
16	0.531	0.469	0.004011	0.004004	+0.17
32	0.633	0.367	0.004169	0.004190	-0.50

TABLE [illegible]

Results of [illegible] Tropical and Subtropical Cyclones at [illegible].

Y	[illegible]	[illegible]	[illegible]
1	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]
6	[illegible]	[illegible]	[illegible]
7	[illegible]	[illegible]	[illegible]
8	[illegible]	[illegible]	[illegible]
9	[illegible]	[illegible]	[illegible]
10	[illegible]	[illegible]	[illegible]
11	[illegible]	[illegible]	[illegible]
12	[illegible]	[illegible]	[illegible]

TABLE [illegible]

Results of [illegible] Tropical and Subtropical Cyclones at [illegible].

Y	X	X - I	[illegible]	[illegible]	[illegible]
1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table XXXVII

K_i and K_m for Sodium Ethylate and Methyl Iodide at 0°C.

V	K_i	K_m
1 : 2	0.004598	0.003074
1 : 4	0.004883	0.003010
1 : 8	0.004896	0.003027
1 : 16	0.004878	0.003030
1 : 32	0.004824	0.003038
2 : 4	0.005109	0.002915
2 : 8	0.004995	0.002950
2 : 16	0.004930	0.002970
2 : 32	0.004849	0.002995
4 : 8	0.004914	0.003014
4 : 16	0.004874	0.003033
4 : 32	0.004808	0.003066
8 : 16	0.004846	0.003065
8 : 32	0.004778	0.003116
16 : 32	0.004737	0.003188
Average =	0.004861	0.003033

TABLE 11(11)

ξ_1^2 and ξ_2^2 for Indian Tobacco and Sweet Potato at 1 Acre.

ξ_1^2	ξ_2^2	N
[illegible]	[illegible]	1 : 1
[illegible]	[illegible]	2 : 1
[illegible]	[illegible]	3 : 1
[illegible]	[illegible]	11 : 1
[illegible]	[illegible]	12 : 1
[illegible]	[illegible]	1 : 2
[illegible]	[illegible]	2 : 2
[illegible]	[illegible]	11 : 2
[illegible]	[illegible]	12 : 2
[illegible]	[illegible]	1 : 3
[illegible]	[illegible]	2 : 3
[illegible]	[illegible]	11 : 3
[illegible]	[illegible]	12 : 3
[illegible]	[illegible]	1 : 4
[illegible]	[illegible]	2 : 4
[illegible]	[illegible]	11 : 4
[illegible]	[illegible]	12 : 4
[illegible]	[illegible]	11 : 11
[illegible]	[illegible]	12 : 11
[illegible]	[illegible]	12 : 12

[illegible] [illegible] = [illegible]

Potassium Ethylate and Methyl Iodide at 0°

Table XXXVIII

0.35 N Potassium Ethylate and

0.35 N Methyl Iodide at 0°

A = 10.00

t	x	K_v
110	0.973	0.000980
190	1.600	0.001002
290	2.368	0.001015
350	2.604	0.001006
390	2.804	0.000997
1430	5.936	0.001038
1590	6.196	0.001034

Average= 0.001006

K_n = 0.004034

Table XXXIX

0.35 N Potassium Ethylate and

0.35 N Methyl Iodide at 0°

A = 10.02

t	x	K_v
130	1.086	0.001014
180	1.506	0.000984
300	2.394	0.000991
440	3.036	0.000985
530	3.418	0.000997
373	2.710	0.000995
1371	5.636	0.001010

Average = 0.000997

K_n = 0.003983

Table XL

0.35 N Potassium Ethylate and

0.50 N Methyl Iodide at 0°.

A = 9.97 B = 30.00

t	x	K_v
130	2.066	0.001030
150	2.490	0.001022
180	2.870	0.001019
190	2.978	0.001013
210	3.234	0.001031

Average = 0.001019

K_n = 0.004088

Table XLI

0.1875 N Potassium Ethylate and

0.50 N Methyl Iodide at 0°.

A = 9.98 B = 26.67

t	x	K_v
90	1.639	0.0007705
130	2.279	0.0007813
160	2.679	0.0007734
180	2.940	0.0007713
220	3.436	0.0007731
260	3.890	0.0007733

Average = 0.0007735

K_n = 0.004133

K_n' = 0.004133

Transmission Coefficients and Reflection Coefficients for $\lambda^{\prime}$

Table XXXVIII

Transmission Coefficients and Reflection Coefficients for $\lambda^{\prime}$ = 0.01 Incident Energy of $\lambda^{\prime}$ = 27.10

γ	α	β^2
100	0.000	0.000000
150	0.000	0.000000
200	0.000	0.000000
250	0.000	0.000000
300	0.000	0.000000
350	0.000	0.000000
400	0.000	0.000000
450	0.000	0.000000

Average = 0.000000

β^2 = 0.000000

Table XXXIX

Transmission Coefficients and Reflection Coefficients for $\lambda^{\prime}$ = 0.02 Incident Energy of $\lambda^{\prime}$ = 27.10

γ	α	β^2
100	0.000	0.000000
150	0.000	0.000000
200	0.000	0.000000
250	0.000	0.000000
300	0.000	0.000000
350	0.000	0.000000
400	0.000	0.000000
450	0.000	0.000000

Average = 0.000000

β^2 = 0.000000

Table XL

Transmission Coefficients and Reflection Coefficients for $\lambda^{\prime}$ = 0.03 Incident Energy of $\lambda^{\prime}$ = 27.10

γ	α	β^2
100	0.000	0.000000
150	0.000	0.000000
200	0.000	0.000000
250	0.000	0.000000
300	0.000	0.000000
350	0.000	0.000000
400	0.000	0.000000
450	0.000	0.000000

Average = 0.000000

β^2 = 0.000000

Table XLI

Transmission Coefficients and Reflection Coefficients for $\lambda^{\prime}$ = 0.04 Incident Energy of $\lambda^{\prime}$ = 27.10

γ	α	β^2
100	0.000	0.000000
150	0.000	0.000000
200	0.000	0.000000
250	0.000	0.000000
300	0.000	0.000000
350	0.000	0.000000
400	0.000	0.000000
450	0.000	0.000000

Average = 0.000000

β^2 = 0.000000

Table XLII

0.1875 N Potassium Ethylate and

0.35 N Methyl Iodide at 0°.

A = 10.03 B = 13.33

t	x	K_v
130	1.119	0.0007755
150	1.375	0.0007818
200	1.753	0.0007769
250	2.116	0.0007790
330	2.564	0.0007755
370	2.857	0.0007738
480	3.417	0.0007630

Average = 0.0007749

K_n = 0.004134

Table XLIII

0.135 N Potassium Ethylate and

0.50 N Methyl Iodide at 0°.

A = 10.02 B = 40.00

t	x	K_v
260	4.044	0.0005278
320	4.692	0.0005292
380	5.260	0.0005304
450	5.820	0.0005293
503	6.304	0.0005288

Average = 0.0005291

K_n = 0.004234

Table XLIV

0.135 N Potassium Ethylate and

0.50 N Methyl Iodide at 0°.

A = 10.00 B = 40.00

t	x	K_v
190	3.192	0.0005285
240	3.832	0.0005311
290	4.376	0.0005282
330	4.792	0.0005299
360	5.064	0.0005280
390	5.360	0.0005331
460	5.880	0.0005271

Average =0.0005294

K_n =0.004235

Table XLV

0.135 N Potassium Ethylate and

0.50 N Methyl Iodide at 0°.

A = 10.00 B = 40.00

t	x	K_v
160	3.784	0.0005291
190	3.200	0.0005301
230	3.720	0.0005326
250	3.968	0.0005345
267	4.152	0.0005328
300	4.512	0.0005336

Average = 0.0005331

K_n = 0.004257

TABLE 1(1)

7.126 2 Transmission Frequency and 7.126 2 Output Voltage at 7°.

$L = 12.00$ $C = 0.0$

f	A	E_o^2
100	1.000	1.000000
200	1.000	1.000000
300	1.000	1.000000
400	1.000	1.000000
500	1.000	1.000000
600	1.000	1.000000
700	1.000	1.000000
800	1.000	1.000000

Average = 1.000000

E_o = 1.000000

TABLE 1(2)

7.126 2 Transmission Frequency and 7.126 2 Output Voltage at 7°.

$L = 12.00$ $C = 0.0$

f	A	E_o^2
100	1.000	1.000000
200	1.000	1.000000
300	1.000	1.000000
400	1.000	1.000000
500	1.000	1.000000
600	1.000	1.000000
700	1.000	1.000000
800	1.000	1.000000

Average = 1.000000

E_o = 1.000000

TABLE 1(3)

7.126 2 Transmission Frequency and 7.126 2 Output Voltage at 7°.

$L = 12.00$ $C = 0.0$

f	A	E_o^2
100	1.000	1.000000
200	1.000	1.000000
300	1.000	1.000000
400	1.000	1.000000
500	1.000	1.000000
600	1.000	1.000000
700	1.000	1.000000
800	1.000	1.000000

Average = 1.000000

E_o = 1.000000

TABLE 1(4)

7.126 2 Transmission Frequency and 7.126 2 Output Voltage at 7°.

$L = 12.00$ $C = 0.0$

f	A	E_o^2
100	1.000	1.000000
200	1.000	1.000000
300	1.000	1.000000
400	1.000	1.000000
500	1.000	1.000000
600	1.000	1.000000
700	1.000	1.000000
800	1.000	1.000000

Average = 1.000000

E_o = 1.000000

Table XLVI

0.09375 N Potassium Ethylate and

0.50 N Methyl Iodide at 0°.

A = 10.00 B = 53.33

t	x	K_v
120	2.367	0.0004108
180	3.142	0.0004056
220	3.685	0.0004070
260	4.187	0.0004089
365	5.364	0.0004068
420	5.733	0.0004055

Average =0.0004074

K_n =0.004347

Table XLVII

0.09375 N Potassium Ethylate and

0.50 N Methyl Iodide at 0°.

A = 10.04 B = 53.33

t	x	K_v
180	3.192	0.0004135
210	3.598	0.0004130
260	4.306	0.0004109
320	4.834	0.0004058

Average = 0.0004108

K_n = 0.004362

Table XLVIII

0.09375 N Potassium Ethylate and

0.50 N Methyl Iodide at 0°.

A = 10.00 B = 53.33

t	x	K_v
120	2.356	0.0004089
180	3.131	0.0004039
220	3.664	0.0004039
270	4.293	0.0004076
420	5.723	0.0004043

Average = 0.0004057

K_n = 0.004329

Table XLIX

0.0625 N Potassium Ethylate and

0.50 N Methyl Iodide at 0°.

A = 10.00 B = 80.00

t	x	K_v
120	2.376	0.0002836
150	2.856	0.0002837
190	3.448	0.0002821
250	4.300	0.0002803
300	4.738	0.0002757
360	5.376	0.0002784
420	5.904	0.0002774

Average = 0.0002800

K_n = 0.004480

TABLE [illegible]

[illegible] a transmission frequency and [illegible] a supply voltage as [illegible].

$\lambda = [illegible]$ $\nu = [illegible]$

ν	α	δ_ν
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Average = [illegible]

δ_ν = [illegible]

TABLE [illegible]

[illegible] a transmission frequency and [illegible] a supply voltage as [illegible].

$\lambda = [illegible]$ $\nu = [illegible]$

ν	α	δ_ν
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Average = [illegible]

δ_ν = [illegible]

TABLE [illegible]

[illegible] a transmission frequency and [illegible] a supply voltage as [illegible].

$\lambda = [illegible]$ $\nu = [illegible]$

ν	α	δ_ν
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Average = [illegible]

δ_ν = [illegible]

TABLE [illegible]

[illegible] a transmission frequency and [illegible] a supply voltage as [illegible].

$\lambda = [illegible]$ $\nu = [illegible]$

ν	α	δ_ν
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Average = [illegible]

δ_ν = [illegible]

Table L

0.0625 N Potassium Ethylate and

0.50 N Methyl Iodide at 0°.

A = 10.08 B = 80.00

t	x	K_v
180	3.272	0.0002808
330	3.938	0.0002778
390	4.672	0.0002796
350	5.304	0.0002794
430	6.008	0.0002777
500	6.544	0.0002774

Average = 0.0002788

K_n = 0.004424

Table LI

0.0625 N Potassium Ethylate and

0.1343 N Methyl Iodide at 0°.

A = 10.07 B = 31.47

t	x	K_v
835	3.638	0.0002777
910	3.838	0.0002745
935	3.894	0.0002726
1010	4.134	0.0002746
1080	4.302	0.0002736
1240	4.702	0.0002718
1365	4.936	0.0002694

Average = 0.0002733

K_n = 0.004343

Table LII

0.0625 N Potassium Ethylate and

0.35 N Methyl Iodide at 0°.

A = 10.03 B = 40.00

t	x	K_v
600	4.526	0.0002677
630	4.734	0.0002732
670	4.902	0.0002697
720	5.174	0.0002727
780	5.406	0.0002699

Average = 0.0002704

K_n = 0.004300

Table LIII

0.0625 N Potassium Ethylate and

0.50 N Methyl Iodide at 0°.

A = 10.03 B = 80.00

t	x	K_v
130	2.478	0.0002781
180	3.152	0.0002715
310	3.598	0.0002718
360	4.302	0.0002783
340	5.214	0.0002808
430	5.902	0.0002768

Average = 0.0002763

K_n = 0.004405

TABLE 1

1,000 Z Transmission Coefficients and

0.90 Z Energy Index at C^2.

$Z = 32.00$ $E = 90.00$

E	α	T^2
200	2.000	0.000000
300	2.100	0.000000
400	2.200	0.000000
500	2.300	0.000000
600	2.400	0.000000
700	2.500	0.000000
800	2.600	0.000000

Average = 0.000000

T^2_{av} = 0.000000

TABLE 2

1,000 Z Transmission Coefficients and

0.90 Z Energy Index at C^2.

$Z = 32.00$ $E = 90.00$

E	α	T^2
200	2.000	0.000000
300	2.100	0.000000
400	2.200	0.000000
500	2.300	0.000000
600	2.400	0.000000
700	2.500	0.000000
800	2.600	0.000000

Average = 0.000000

T^2_{av} = 0.000000

TABLE 3(1)

1,000 Z Transmission Coefficients and

0.90 Z Energy Index at C^2.

$Z = 32.00$ $E = 90.00$

E	α	T^2
200	2.000	0.000000
300	2.100	0.000000
400	2.200	0.000000
500	2.300	0.000000
600	2.400	0.000000
700	2.500	0.000000
800	2.600	0.000000

Average = 0.000000

T^2_{av} = 0.000000

TABLE 3(2)

1,000 Z Transmission Coefficients and

0.90 Z Energy Index at C^2.

$Z = 32.00$ $E = 90.00$

E	α	T^2
200	2.000	0.000000
300	2.100	0.000000
400	2.200	0.000000
500	2.300	0.000000
600	2.400	0.000000
700	2.500	0.000000
800	2.600	0.000000

Average = 0.000000

T^2_{av} = 0.000000

Table LIV

0.03135 N Potassium Ethylate and

0.135 N Methyl Iodide at 0°.

A = 10.03 B = 40.00

t	x	K_v
890	3.764	0.0001397
1000	4.098	0.0001393
1110	4.444	0.0001409
1300	4.604	0.0001373
1330	4.980	0.0001403
1413	5.358	0.0001417

Average = 0.0001398

K_n = 0.004466

Table LV

0.03135 N Potassium Ethylate and

0.35 N Methyl Iodide at 0°.

A = 10.00 B = 80.00

t	x	K_v
650	4.936	0.0001355
700	5.364	0.0001385
730	5.456	0.0001405
760	5.584	0.0001400
800	5.713	0.0001379
840	5.888	0.0001381
990	6.424	0.0001363

Average = 0.0001381

K_n = 0.004419

Table LVI

0.03135 N Potassium Ethylate and

0.35 N Methyl Iodide at 0°.

A = 10.03 B = 80.00

t	x	K_v
180	1.830	0.0001430
240	2.350	0.0001416
330	2.894	0.0001360
360	3.330	0.0001383
420	3.743	0.0001430
480	4.094	0.0001409

Average = 0.0001403

K_n = 0.004476

Table LVII

0.03135 N Potassium Ethylate and

0.35 N Methyl Iodide at 0°.

A = 10.01 B = 80.00

t	x	K_v
160	1.643	0.0001415
330	3.358	0.0001475
370	3.554	0.0001390
340	3.130	0.0001409
390	3.554	0.0001441
450	3.933	0.0001430

Average = 0.0001435

K_n = 0.004556

Table [illegible]

[illegible] Transmission Efficiency and [illegible] Energy Ratio as f'.

[illegible] $\Omega = 0.0$

f'	Ω	η_T
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Average = [illegible]

η_T = [illegible]

Table [illegible]

[illegible] Transmission Efficiency and [illegible] Energy Ratio as f'.

[illegible] $\Omega = 0.0$

f'	Ω	η_T
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Average = [illegible]

η_T = [illegible]

Table [illegible]

[illegible] Transmission Efficiency and [illegible] Energy Ratio as f'.

[illegible] $\Omega = 0.0$

f'	Ω	η_T
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Average = [illegible]

η_T = [illegible]

Table [illegible]

[illegible] Transmission Efficiency and [illegible] Energy Ratio as f'.

[illegible] $\Omega = 0.0$

f'	Ω	η_T
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Average = [illegible]

η_T = [illegible]

Table LVIII

0.03125 N Potassium Ethylate and 0.35 N Methyl Iodide at 0°.

A = 10.00 B = 80.00

t	x	K_v
140	1.448	0.0001409
300	1.952	0.0001374
250	2.434	0.0001410
320	2.960	0.0001398
380	3.440	0.0001419
430	3.736	0.0001394

Average =0.0001401

K_n =0.004482

Table LIX

0.03125 N Potassium Ethylate and 0.50 N Methyl Iodide at 0°.

A = 10.00 B =160.00

t	x	K_v
190	3.528	0.0001446
220	3.968	0.0001454
270	4.568	0.0001433
360	5.480	0.0001404
430	6.080	0.0001423

Average =0.0001432

K_n =0.004582

Table LX

Summary of Potassium Ethylate and Methyl Iodide at 0°.

V	K_n	Average K_n
4	0.004034	
	0.003982	
	0.004088	0.004031
16/3	0.004123	
	0.004124	0.004124
	0	
8	0.004334	
	0.004335	
	0.004258	0.004339
32/3	0.004347	
	0.004362	
	0.004329	0.004346
16	0.004480	
	0.004300	
	0.004434	
	0.004343	
	0.004405	0.004390
32	0.004466	
	0.004419	
	0.004582	
	0.004476	
	0.004556	
	0.004482	0.004497

Table 1.

Summary of Transmission Thickness and Energy Indices at 0°.

T	T_p^0	Average T_p^0
4	1.000000	
	0.000000	
	0.000000	
		0.000000
14.5	0.000000	
	0.000000	0.000000
	0	
8	0.000000	
	0.000000	
	0.000000	0.000000
11.5	0.000000	
	0.000000	
	0.000000	0.000000
12	0.000000	
	0.000000	
	0.000000	
	0.000000	
	0.000000	0.000000
15	0.000000	
	0.000000	
	0.000000	
	0.000000	
	0.000000	
	0.000000	
	0.000000	0.000000

Table 2.

Summary of Transmission Thickness and Energy Indices at 0°.

$t = 10.00$ $\quad \delta = 0.000000$

τ	α	T_p^0
100	1.000	0.000000
200	1.000	0.000000
300	1.000	0.000000
400	1.000	0.000000
500	1.000	0.000000
600	1.000	0.000000
700	1.000	0.000000
800	1.000	0.000000
900	1.000	0.000000
950	1.750	0.000000

Average $= 0.000000$

$T_p^0 = 0.000000$

Table 3.

Summary of Transmission Thickness and Energy Indices at 0°.

$t = 10.00$ $\quad \delta = 0.000000$

τ	α	T_p^0
100	1.000	0.000000
200	1.000	0.000000
300	1.000	0.000000
400	1.000	0.000000
500	1.000	0.000000
600	1.000	0.000000
700	1.000	0.000000
800	1.000	0.000000
900	1.000	0.000000
950	1.750	0.000000

Average $= 0.000000$

$T_p^0 = 0.000000$

Table LXI

Potassium Ethylate and Methyl Iodide at 0°C.

V	α	1 - α	K_n found	K_n calculated	Per cent. error
4	0.365	0.635	0.004031	0.004055	-0.62
16/3	0.401	0.599	0.004124	0.004123	+0.02
8	0.459	0.541	0.004339	0.004333	+0.12
32/3	0.491	0.509	0.004346	0.004292	+1.26
16	0.546	0.454	0.004390	0.004397	-0.10
32	0.637	0.363	0.004497	0.004568	-1.55

Table LXII

K_i and K_m for Potassium Ethylate and Methyl Iodide at 0°.

V	K_i	K_m
4 : 8	0.00543	0.00320
4 : 32/3	0.00562	0.00310
4 : 16	0.00528	0.00329
4 : 32	0.00513	0.00340
16/3 : 32/3	0.00564	0.00306
16/3 : 16	0.00532	0.00335
16/3 : 32	0.00508	0.00348
8 : 16	0.00517	0.00345
8 : 32	0.00502	0.00359
16 : 32	0.00493	0.00377
Average =	0.00525	0.00337

TABLE [illegible]

[illegible] and [illegible] [illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE [illegible]

[illegible] and [illegible] for Transition Frequency and Period [illegible] [illegible]

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Sodium Ethylate and Methyl Iodide at 25°C.

Table LXIII

0.5 N Sodium Ethylate and

0.5 N Methyl Iodide at 25°C.

A = 10.00

t	x	K_v
20	4.343	0.03839
30	5.337	0.03815
40	5.999	0.03745
50	6.495	0.03714
60	6.901	0.03711
70	7.187	0.03650

Average = 0.03746

K_n = 0.07492

Table LXIV

0.5 N Sodium Ethylate and

0.5095 N Methyl Iodide at 25°C.

A = 10.00 B = 10.19

t	x	K_v
15	3.657	0.03715
24	4.830	0.03786
33	5.600	0.03745
42	6.166	0.03691
51	6.586	0.03634
69	7.307	0.03564
97	7.815	0.03500

Average = 0.03662

K_n = 0.07324

Table LXV

0.5 N Sodium Ethylate and

0.35 N Methyl Iodide at 25°C.

A = 20.00 B = 10.00

t	x	K_v
15	4.044	0.03894
25	5.492	0.03805
35	6.476	0.03723
55	7.818	0.03732
65	8.196	0.03646
75	8.530	0.03613

Average = 0.03735

K_n = 0.07471

Table LXVI

0.5 N Sodium Ethylate and

0.5 N Methyl Iodide at 25°C.

A = 9.989

t	x	K_v
10	3.891	0.04073
20	4.375	0.03896
30	5.367	0.03870
40	6.037	0.03803
50	6.527	0.03770
60	6.889	0.03703
70	7.175	0.03643

Average = 0.03832

K_n = 0.07652

[illegible]

TABLE [illegible]

[illegible] = [illegible]

[illegible] = [illegible]

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

[illegible] = [illegible]

[illegible] = [illegible]

TABLE [illegible]

[illegible] = [illegible]

[illegible] = [illegible]

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

[illegible] = [illegible]

[illegible] = [illegible]

TABLE [illegible]

[illegible] = [illegible]

[illegible] = [illegible]

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

[illegible] = [illegible]

[illegible] = [illegible]

Table LXVII

0.5 N Sodium Ethylate and

0.35 N Methyl Iodide at 35°C.

A = 20.04 B = 10.00

t	x	K_v
20	4.780	0.03768
30	6.033	0.03766
37	6.676	0.03755
43	7.120	0.03740
50	7.520	0.03687
59	7.933	0.03636
68	8.308	0.03643

Average = 0.03712

K_n = 0.07409

Table LXVIII

0.35 N Sodium Ethylate and

0.35 N Methyl Iodide at 35°C.

A = 10.00

t	x	K_v
10	1.685	0.03036
20	2.909	0.03051
30	3.760	0.03008
40	4.446	0.03001
50	5.000	0.03000
60	5.430	0.01980
70	5.793	0.01967

Average = 0.03005

K_n = 0.08020

Table LXIX

0.35 N Sodium Ethylate and

0.50 N Methyl Iodide at 35°C.

A = 10.03 B = 20.00

t	x	K_v
15	4.152	0.03024
25	5.668	0.03009
35	6.683	0.01988
45	7.418	0.01973
55	7.956	0.01934
65	8.363	0.01943
75	8.698	0.01947

Average = 0.01974

K_n = 0.07880

Table LXX

0.35 N Sodium Ethylate and

0.35 N Methyl Iodide at 35°C.

A = 9.956

t	x	K_v
20	2.868	0.03023
25	3.340	0.03019
30	3.758	0.03021
40	4.453	0.03023
50	4.980	0.03002
60	5.430	0.01991

Average = 0.03013

K_n = 0.08086

Table LXXI

0.35 N Sodium Ethylate and

0.35 N Methyl Iodide at 35°C.

A = 10.01

t	x	K_v
20	2.918	0.02057
25	3.354	0.02015
30	3.768	0.02012
40	4.455	0.02005
46	4.795	0.01998
52	5.076	0.01978

Average = 0.02011

K_n = 0.08035

Table LXXII

0.125 N Sodium Ethylate and

0.125 N Methyl Iodide at 25°C.

A = 10.00

t	x	K_v
40	2.959	0.01051
55	3.691	0.01064
70	4.223	0.01045
80	4.575	0.01054
90	4.852	0.01047
100	5.111	0.01045

Average = 0.01051

K_n = 0.08406

Table LXXIII

0.125 N Sodium Ethylate and

0.25 N Methyl Iodide at 25°C.

A = 10.00 B = 20.00

t	x	K_v
15	2.594	0.01075
25	3.236	0.01082
35	4.830	0.01094
45	5.548	0.01075
55	6.163	0.01072
65	6.686	0.01072
75	7.103	0.01067

Average = 0.01077

K_n = 0.08616

Table LXXIV

0.125 N Sodium Ethylate and

0.25 N Methyl Iodide at 25°C.

A = 10.03 B = 20.00

t	x	K_v
20	3.318	0.01107
26	3.982	0.01098
34	4.734	0.01090
42	5.382	0.01091
47	5.734	0.01091
57	6.318	0.01084

Average = 0.01094

K_n = 0.08722

Table (XXXI)

Table (XXXII)

Table (XXXIII)

Table (XXXIV)

Table LXXV

0.125 N Sodium Ethylate and

0.25 N Methyl Iodide at 25°C.

A = 10.00 B = 20.00

t	x	K_v
15	3.648	0.01103
25	3.848	0.01088
32	4.560	0.01094
38	5.080	0.01095
46	5.656	0.01090
52	5.993	0.01073
58	6.312	0.01066

Average = 0.01087

K_n = 0.08696

Table LXXVI

0.0625 N Sodium Ethylate and

0.25 N Methyl Iodide at 25°C.

A = 10.00 B = 41.00

t	x	K_v
15	3.889	0.005475
25	4.311	0.005842
35	5.366	0.005792
45	6.180	0.005725
55	6.884	0.005759
65	7.435	0.005934

Average = 0.005754

K_n = 0.09206

Table LXXVII

0.0625 N Sodium Ethylate and

0.25 N Methyl Iodide at 25°C.

A = 10.00 B = 40.00

t	x	K_v
15	3.800	0.005678
25	4.181	0.005746
35	5.256	0.005771
45	6.105	0.005768
55	7.000	0.006123
65	7.436	0.005911
75	7.724	0.005622

Average = 0.005803

K_n = 0.09198

Table LXXVIII

0.03125 N Sodium Ethylate and

0.25 N Methyl Iodide at 25°C.

A = 9.912 B = 80.00

t	x	K_v
15	3.001	0.003039
25	4.550	0.003144
35	5.607	0.003075
45	6.305	0.003088
55	7.184	0.003074
65	7.741	0.003081

Average = 0.003082

K_n = 0.09948

TABLE [illegible]

[illegible] & [illegible] Frequency and

[illegible] & Weight Index as [illegible].

$\lambda = [illegible]$ $\theta = [illegible]$

γ	α	$\hat{\mu}_\gamma$
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Average = [illegible]

$\hat{\mu}_\gamma$ = [illegible]

TABLE [illegible]

[illegible] & Relative Frequency and

[illegible] & Weight Index as [illegible].

$\lambda = [illegible]$ $\theta = [illegible]$

γ	α	$\hat{\mu}_\gamma$
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Average = [illegible]

$\hat{\mu}_\gamma$ = [illegible]

TABLE [illegible]

[illegible] & [illegible] Frequency and

[illegible] & Weight Index as [illegible].

$\lambda = [illegible]$ $\theta = [illegible]$

γ	α	$\hat{\mu}_\gamma$
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Average = [illegible]

$\hat{\mu}_\gamma$ = [illegible]

TABLE [illegible]

[illegible] & Relative Frequency and

[illegible] & Weight Index as [illegible].

$\lambda = [illegible]$ $\theta = [illegible]$

γ	α	$\hat{\mu}_\gamma$
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Average = [illegible]

$\hat{\mu}_\gamma$ = [illegible]

Table LXXIX

0.03125 N Sodium Ethylate and

0.125 N Methyl Iodide at 25°C.

A = 10.07 B = 40.00

t	x	K_v
55	4.876	0.003252
80	5.893	0.003029
100	6.783	0.003143
135	7.733	0.003104
150	8.038	0.003085
180	8.482	0.003007

Average = 0.003103

K_n = 0.09860

Table LXXX

0.03125 N Sodium Ethylate and

0.25 N Methyl Iodide at 25°C.

A = 10.00 B = 80.00

t	x	K_v
20	3.780	0.003045
25	4.467	0.003053
30	5.168	0.003144
35	5.504	0.003972
40	6.120	0.003098
45	6.595	0.003145
50	6.956	0.003137

Average = 0.003085

K_n = 0.09872

Table LXXXI

Summary of Sodium Ethylate and Methyl Iodide at 25°C.

V	K_n	Average K_n
2	0.07492	
	0.07334	
	0.07471	
	0.07653	
	0.07409	0.07470
4	0.08030	
	0.07880	
	0.08086	
	0.08035	0.08005
8	0.08406	
	0.08616	
	0.08732	
	0.08696	0.08610
16	0.09306	
	0.09198	0.09202
32	0.09872	
	0.09948	
	0.09860	0.09893

TABLE [illegible]

[illegible] a random function and

[illegible] a random variable of [illegible].

$\lambda = 50/00$ $\lambda = 0/00$

i	x	y^2
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Average $= 0.00014$

$\sigma^2 = 0.00000$

TABLE [illegible]

[illegible] a random function and

[illegible] a random variable of [illegible].

$\lambda = 12/00$ $\lambda = 10/00$

i	x	y^2
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Average $= 0.00014$

$\sigma^2 = 0.00014$

TABLE [illegible]

Theory of random functions and stochastic [illegible] of [illegible].

λ	σ^2	Average σ^2
[illegible]	[illegible]	
	[illegible]	
	[illegible]	
	[illegible]	
	[illegible]	[illegible]
[illegible]	[illegible]	
	[illegible]	
	[illegible]	
	[illegible]	[illegible]
[illegible]	[illegible]	
	[illegible]	
	[illegible]	
	[illegible]	[illegible]
[illegible]	[illegible]	
	[illegible]	[illegible]
[illegible]	[illegible]	
	[illegible]	
	[illegible]	[illegible]

Table LXXXII

Sodium Ethylate and Methyl Iodide at 25°C.

V	α	$1 - \alpha$	K_n found	K_n calculated	Per cent. error
2	0.234	0.766	0.07470	0.07466	+0.053
4	0.312	0.688	0.08005	0.08026	-0.26
8	0.393	0.607	0.08610	0.08590	+0.23
16	0.481	0.519	0.09202	0.09191	+0.12
32	0.584	0.416	0.09893	0.09909	-0.16

Table LXXXIII

K_i and K_m for Sodium Ethylate and Methyl Iodide at 25°C.

V	K_i	K_m
2 : 4	0.1272	0.05865
2 : 8	0.1296	0.05792
2 : 16	0.1284	0.05839
2 : 32	0.1277	0.05850
4 : 8	0.1313	0.05674
4 : 16	0.1288	0.05795
4 : 32	0.1278	0.05839
8 : 16	0.1269	0.05966
8 : 32	0.1269	0.05970
16 : 32	0.1268	0.05994
Average =	0.1281	0.05857

TABLE (XXII)

Values θ_1, θ_2 and θ_3 for the Sample Shown in Fig. 9.

γ	α	$\beta - \alpha$	θ_1 (Known)	θ_2 (Calculated for each γ)	θ_3 (Calculated for each γ)
0	0.000	0.000	0.00000	0.00000	0.0000
0	0.000	0.000	0.00000	0.00000	-0.00
0	0.000	0.000	0.00000	0.00000	0.00
10	0.000	0.000	0.00000	0.00000	0.00
20	0.000	0.000	0.00000	0.00000	-0.00

TABLE (XXIII)

θ_1 and θ_2 for Random Fragments and Natural Sample in Fig. 9.

γ	θ_1	θ_2
0 : 0	0.0000	0.0000
0 : 1	0.0000	0.0000
0 : 10	0.0000	0.0000
0 : 20	0.0000	0.0000
0 : 0	0.0000	0.0000
0 : 10	0.0000	0.0000
0 : 20	0.0000	0.0000
0 : 30	0.0000	0.0000
0 : 40	0.0000	0.0000
0 : 50	0.0000	0.0000
0 : 60	0.0000	0.0000

Average = 0.0000 0.0000

SALT EFFECT

Sodium Ethylate, Methyl Iodide and Sodium Iodide at 25 °C.

Table LXXXIV

0.25 N Sodium Ethylate,

0.25 N Methyl Iodide and

0.25 N Sodium Iodide at 25°C.

A = 9.971

t	x	K_v
15	2.067	0.01743
25	3.031	0.01747
31	3.500	0.01744
40	4.097	0.01744
48	4.528	0.01733
57	4.953	0.01732
66	5.307	0.01724

Average = 0.01738

K_n = 0.06972

Table LXXXV

0.25 N Sodium Ethylate,

0.25 N Methyl Iodide and

0.25 N Sodium Iodide at 25°C.

A = 10.01

t	x	K_v
15	2.078	0.01747
23	2.874	0.01751
31	3.506	0.01739
41	4.170	0.01743
48	4.547	0.01734
56	4.930	0.01734
64	5.262	0.01732

Average = 0.01740

K_n = 0.06953

Table LXXXVI

0.25 N Sodium Ethylate,

0.25 N Methyl Iodide and

0.75 N Sodium Iodide.

A = 9.98

t	x	K_v
15	1.828	0.01495
23	2.538	0.01483
31	3.144	0.01484
41	3.750	0.01468
50	4.233	0.01473
60	4.657	0.01458
71	5.098	0.01471

Average = 0.01476

K_n = 0.05915

Table LXXXVII

0.25 N Sodium Ethylate and

0.25 N Methyl Iodide and

0.75 N Sodium Iodide.

A = 9.98

t	x	K_v
15	1.864	0.01531
24	2.628	0.01489
34	3.344	0.01483
43	3.864	0.01469
53	4.373	0.01471
63	4.804	0.01473
73	5.130	0.01463

Average = 0.01483

K_n = 0.05943

NOLL STUDY

Table 1(a)(i): Total non-random errors in ξ_1 %.

Table (a)(ii)

0.04 2 Medium Thickness.

0.05 2 Normal Inlets and

0.07 2 Medium Inlets in 20'C.

$\xi = 0.375$

γ	α	ξ_r
10	0.[illegible]	0.[illegible]
20	0.[illegible]	0.[illegible]
30	0.[illegible]	0.[illegible]
40	0.[illegible]	0.[illegible]
50	0.[illegible]	0.[illegible]
60	0.[illegible]	0.[illegible]
70	0.[illegible]	0.[illegible]

Average = 0.[illegible]

ξ_r = 0.[illegible]

Table (a)(iii)

0.04 2 Medium Thickness

0.05 2 Normal Inlets and

0.07 2 Medium Inlets in 20'C.

$\xi = 0.25$

γ	α	ξ_r
10	0.[illegible]	0.[illegible]
20	0.[illegible]	0.[illegible]
30	0.[illegible]	0.[illegible]
40	0.[illegible]	0.[illegible]
50	0.[illegible]	0.[illegible]
60	0.[illegible]	0.[illegible]
70	0.[illegible]	0.[illegible]

Average = 0.[illegible]

ξ_r = 0.[illegible]

Table (a)(iv)

0.04 2 Medium Thickness

0.05 2 Normal Inlets and

0.07 2 Medium Inlets.

$\xi = 0.25$

γ	α	ξ_r
10	0.[illegible]	0.[illegible]
20	0.[illegible]	0.[illegible]
30	0.[illegible]	0.[illegible]
40	0.[illegible]	0.[illegible]
50	0.[illegible]	0.[illegible]
60	0.[illegible]	0.[illegible]
70	0.[illegible]	0.[illegible]

Average = 0.[illegible]

ξ_r = 0.[illegible]

Table (a)(v)

0.04 2 Medium Thickness and

0.05 2 Normal Inlets and

0.07 2 Medium Inlets.

$\xi = 0.25$

γ	α	ξ_r
10	0.[illegible]	0.[illegible]
20	0.[illegible]	0.[illegible]
30	0.[illegible]	0.[illegible]
40	0.[illegible]	0.[illegible]
50	0.[illegible]	0.[illegible]
60	0.[illegible]	0.[illegible]
70	0.[illegible]	0.[illegible]

Average = 0.[illegible]

ξ_r = 0.[illegible]

Table LXXXVIII

0.135 N Sodium Ethylate,

0.35 N Methyl Iodide and

0.135 N Sodium Iodide.

A = 9.98 B = 20.00

t	x	K_v
15	2.394	0.009351
20	3.036	0.009863
28	3.778	0.009473
34	4.337	0.009540
43	4.930	0.009409
50	5.484	0.009498
58	5.916	0.009404

Average = 0.009491

K_n = 0.07608

Table LXXXIX

0.135 N Sodium Ethylate,

0.35 N Methyl Iodide and

0.135 N Sodium Iodide.

A = 9.976 B = 20.00

t	x	K_v
15	2.326	0.009408
23	3.188	0.009560
29	3.906	0.009591
37	4.605	0.009613
44	5.121	0.009596
52	5.634	0.009555
59	5.988	0.009461

Average = 0.009541

K_n = 0.07651

Table XC

0.135 N Sodium Ethylate,

0.35 N Methyl Iodide and

0.375 N Sodium Iodide.

A = 9.99 B = 20.00

t	x	K_v
15	2.095	0.008295
23	2.951	0.008363
33	3.785	0.008307
39	4.356	0.008369
47	4.905	0.008363
54	5.311	0.008312
60	5.655	0.008356

Average = 0.008333

K_n = 0.06664

Table XCI

0.135 N Sodium Ethylate,

0.35 N Methyl Iodide and

0.375 N Sodium Iodide.

A = 10.01 B = 20.00

t	x	K_v
15	2.103	0.008335
23	2.978	0.008358
30	3.656	0.008433
38	4.287	0.008380
47	4.899	0.008340
55	5.390	0.008363
63	5.818	0.008374

Average = 0.008367

K_n = 0.06689

Table XCII

0.125 N Sodium Ethylate,

0.25 N Methyl Iodide and

0.875 N Sodium Iodide.

A = 9.959 B = 30.00

t	x	K_v
15	1.879	0.007299
23	2.634	0.007154
33	3.499	0.007227
40	3.993	0.007181
49	4.556	0.007142
57	4.999	0.007122
64	5.351	0.007116

Average = 0.007177

K_n = 0.05765

Table XCIII

0.125 N Sodium Ethylate,

0.25 N Methyl Iodide and

0.875 N Sodium Iodide.

A = 10.01 B = 30.00

t	x	K_v
15	1.818	0.007023
25	2.774	0.007023
35	3.590	0.007051
44	4.250	0.007144
54	4.818	0.007066
63	5.390	0.007070
73	5.686	0.007025

Average = 0.007057

K_n = 0.05640

Table XCIV

0.0625 N Sodium Ethylate,

0.25 N Methyl Iodide and

0.0625 N Sodium Iodide.

A = 10.10 B = 40.00

t	x	K_v
15	2.626	0.005250
22	3.550	0.005230
28	4.342	0.005218
34	4.886	0.005273
40	5.425	0.005265
46	5.852	0.005197
52	6.276	0.005199

Average =0.005232

K_n =0.08287

Table XCV

0.0625 N Sodium Ethylate,

0.25 N Methyl Iodide and

0.0625 N Sodium Iodide.

A = 10.03 B = 40.00

t	x	K_v
15	2.604	0.005203
21	3.450	0.005279
27	4.156	0.005271
33	4.736	0.005301
38	5.214	0.005230
44	5.694	0.005209
51	6.150	0.005135

Average = 0.005218

K_n = 0.08323

Table (11)

(.000 x Motion Vectors),
(.00 x Quality Factor) and
(.000 x Frame Number.

r	x	S_r^x
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Average = [illegible]

S_r^x = [illegible]

Table (12)

(.000 x Motion Vectors),
(.00 x Quality Factor) and
(.000 x Frame Number.

r	x	S_r^x
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Average = [illegible]

S_r^x = [illegible]

Table (13)

(.000 x Motion Vectors),
(.00 x Quality Factor) and
(.000 x Frame Number.

r	x	S_r^x
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Average = [illegible]

S_r^x = [illegible]

Table (14)

(.000 x Motion Vectors),
(.00 x Quality Factor) and
(.000 x Frame Number.

r	x	S_r^x
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Average = [illegible]

S_r^x = [illegible]

Table XCVI

0.0635 N Sodium Ethylate,

0.25 N Methyl Iodide and

0.0635 N Sodium Iodide.

A = 10.03 B = 40.00

t	x	K_v
10	1.893	0.005357
20	3.305	0.005236
30	4.436	0.005162
40	5.372	0.005188
50	6.106	0.005150
60	6.731	0.005153
70	7.319	0.005107

Average = 0.005192

K_n = 0.08381

Table XCVII

0.0635 N Sodium Ethylate,

0.25 N Methyl Iodide and

0.1875 N Sodium Iodide.

A = 10.08 B = 40.00

t	x	K_v
15	2.336	0.004568
22	3.200	0.004570
28	3.856	0.004580
34	4.468	0.004628
41	5.040	0.004587
49	5.640	0.004590
58	6.184	0.004545

Average =0.004581

K_n =0.07370

Table XCVIII

0.0625 N Sodium Ethylate,

0.25 N Methyl Iodide and

0.1875 N Sodium Iodide.

A = 10.00 B = 40.00

t	x	K_v
15	2.280	0.004444
22	3.184	0.004548
28	3.832	0.004552
34	4.428	0.004581
41	5.024	0.004581
49	5.600	0.004557
57	6.144	0.004595

Average =0.004551

K_n =0.07382

Table XCIX

0.0625 N Sodium Ethylate,

0.25 N Methyl Iodide and

0.4375 N Sodium Iodide.

A = 10.04 B = 40.00

t	x	K_v
15	2.160	0.004171
21	2.848	0.004144
28	3.576	0.004148
35	4.300	0.004125
43	4.784	0.004146
49	5.348	0.004095
56	5.680	0.004074

Average =0.004139

K_n =0.06582

Table C

0.0625 N Sodium Ethylate,

0.25 N Methyl Iodide and

0.4375 N Sodium Iodide.

A = 10.04 B = 40.00

t	x	K_v
15	2.152	0.004152
23	2.944	0.004120
29	3.659	0.004138
36	4.284	0.004123
43	4.882	0.004175
50	5.360	0.004150
56	5.720	0.004122

Average =0.004138

K_n =0.06596

Table CI

0.0625 N Sodium Ethylate,

0.25 N Methyl Iodide and

0.9375 N Sodium Iodide.

A = 10.00 B = 40.00

t	x	K_v
15	1.720	0.003322
25	2.766	0.003361
34	3.592	0.003439
44	4.357	0.003460
53	4.897	0.003409
62	5.380	0.003374

Average = 0.003394

K_n = 0.05430

Table CII

0.0625 N Sodium Ethylate,

0.25 N Methyl Iodide and

0.9375 N Sodium Iodide.

A = 9.99 B = 40.00

t	x	K_v
15	1.826	0.003442
24	2.738	0.003458
33	3.550	0.003490
41	4.186	0.003511
50	4.786	0.003493
59	5.290	0.003459
68	5.770	0.003455

Average =0.003473

K_n =0.05561

Table CIII

0.03125 N Sodium Ethylate,

0.25 N Methyl Iodide and

0.03125 N Sodium Iodide.

A = 10.00 B = 80.00

t	x	K_v
15	2.840	0.003836
25	4.313	0.003817
35	5.320	0.003819
45	6.326	0.003836
55	6.932	0.003834
65	7.456	0.003794
75	7.859	0.003739

Average =0.003811

K_n =0.08995

Table CIV

0.03125 N Sodium Ethylate,

0.25 N Methyl Iodide and

0.03125 N Sodium Iodide.

A = 10.00 B = 80.00

t	x	K_v
15	2.880	0.002886
25	4.336	0.002836
35	5.360	0.002852
45	6.162	0.002786
55	6.904	0.002811
65	7.432	0.002774
75	7.859	0.002740

Average =0.002813

K_n =0.09002

Table CV

0.03125 N Sodium Ethylate,

0.25 N Methyl Iodide and

0.09375 N Sodium Iodide.

A = 10.00 B = 80.00

t	x	K_v
20	3.160	0.002435
30	4.340	0.002445
40	5.289	0.002444
50	6.041	0.002433
60	6.709	0.002436
70	7.246	0.002439

Average =0.002436

K_n =0.07795

Table CVI

0.03125 N Sodium Ethylate,

0.25 N Methyl Iodide and

0.09375 N Sodium Iodide.

A = 10.00 B = 80.00

t	x	K_v
10	1.763	0.002453
20	3.205	0.002468
30	4.459	0.002438
40	5.454	0.002554
50	6.155	0.002502
60	6.814	0.002510
70	7.330	0.002499

Average = 0.002489

K_n = 0.07964

Table CVII

0.03125 N Sodium Ethylate,

0.25 N Methyl Iodide and

0.09375 N Sodium Iodide.

A = 10.07 B = 80.00

t	x	K_v
15	2.518	0.002455
22	3.470	0.002474
28	4.134	0.002444
35	4.870	0.002460
41	5.374	0.002434
49	5.974	0.002415

Average =0.002447

K_n =0.07776

Table CVIII

0.03125 N Sodium Ethylate,

0.25 N Methyl Iodide and

0.21875 N Sodium Iodide.

A = 10.00 B = 80.00

t	x	K_v
15	2.224	0.002126
20	2.880	0.002163
26	3.593	0.002193
33	4.324	0.002207
40	4.856	0.002150
49	5.648	0.002211

Average = 0.002176

K_n = 0.06964

Table CIX

0.03125 N Sodium Ethylate,

0.25 N Methyl Iodide and

0.21875 N Sodium Iodide.

A = 10.05 B = 80.00

t	x	K_v
20	2.898	0.002178
25	3.450	0.002162
30	3.963	0.002156
35	4.442	0.002159
40	4.842	0.002136
45	5.162	0.002087
50	5.594	0.002128

Average = 0.002144

K_n = 0.06832

Table CX

0.03125 N Sodium Ethylate,

0.25 N Methyl Iodide and

0.46875 N Sodium Iodide.

A = 9.944 B = 80.00

t	x	K_v
14	1.816	0.001811
23	2.664	0.001793
32	3.840	0.001946
40	4.544	0.001958
49	5.340	0.001971
58	5.848	0.001984

Average = 0.001911

K_n = 0.06148

Table CXI

0.03125 N Sodium Ethylate,

0.25 N Methyl Iodide and

0.46875 N Sodium Iodide.

A = 10.01 B = 80.00

t	x	K_v
15	2.010	0.001894
24	3.090	0.001965
40	4.482	0.001916
48	5.170	0.001965
56	5.594	0.001904
63	6.074	0.001939

Average = 0.001939

K_n = 0.06199

Table (1)

0.0080 0 Motion Thickness,
0.02 0 Energy Input and
0.0079 0 Motion Input.

$L = 10.00$ $U = 20.00$

t	u	T°
11	0.000	0.00000
12	0.000	0.00000
13	0.000	0.00000
14	0.000	0.00000
15	0.000	0.00000
16	0.000	0.00000
17	0.000	0.00000
18	0.000	0.00000

Average = 0.00000

$T^{\circ} = 0.00000$

Table (2)

0.0080 0 Motion Thickness,
0.02 0 Energy Input and
0.0079 0 Motion Input.

$L = 10.00$ $U = 20.00$

t	u	T°
19	0.000	0.00000
20	0.000	0.00000
21	0.000	0.00000
22	0.000	0.00000
23	0.000	0.00000
24	0.000	0.00000
25	0.000	0.00000
26	0.000	0.00000

Average = 0.00000

$T^{\circ} = 0.00000$

Table (3)

0.0080 0 Motion Thickness,
0.02 0 Energy Input and
0.0079 0 Motion Input.

$L = 10.00$ $U = 20.00$

t	u	T°
27	0.000	0.00000
28	0.000	0.00000
29	0.000	0.00000
30	0.000	0.00000
31	0.000	0.00000
32	0.000	0.00000
33	0.000	0.00000
34	0.000	0.00000

Average = 0.00000

$T^{\circ} = 0.00000$

Table (4)

0.0080 0 Motion Thickness,
0.02 0 Energy Input and
0.0079 0 Motion Input.

$L = 10.00$ $U = 20.00$

t	u	T°
35	0.000	0.00000
36	0.000	0.00000
37	0.000	0.00000
38	0.000	0.00000
39	0.000	0.00000
40	0.000	0.00000
41	0.000	0.00000
42	0.000	0.00000

Average = 0.00000

$T^{\circ} = 0.00000$

Table CXII

0.03125 N Sodium Ethylate,

0.25 N Methyl Iodide and

0.96875 N Sodium Iodide.

A = 9.99 B = 80.00

t	x	K_v
21	2.454	0.001704
29	3.150	0.001666
37	3.886	0.001707
46	4.486	0.001670
54	5.096	0.001710
64	5.574	0.001659

Average = 0.001686

K_n = 0.05400

Table CXIII

0.03125 N Sodium Ethylate,

0.25 N Methyl Iodide and

0.96875 N Sodium Iodide.

A = 10.02 B = 80.00

t	x	K_v
13	1.492	0.001568
21	2.324	0.001587
30	3.220	0.001654
38	3.788	0.001606
46	4.348	0.001597
55	5.044	0.001652
63	5.556	0.001674

Average = 0.001620

K_n = 0.05173

TABLE [illegible]

[illegible] TURBULENT FLOW

[illegible] SMOOTH TUBE,

[illegible] = [illegible] [illegible] = [illegible]

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

[illegible] = [illegible]

[illegible] = [illegible]

TABLE [illegible]

[illegible] TURBULENT FLOW

[illegible] SMOOTH TUBE,

[illegible] = [illegible] [illegible] = [illegible]

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

[illegible] = [illegible]

[illegible] = [illegible]

Table CXIV

Summary of Sodium Ethylate, Methyl Iodide and Sodium Iodide at 25°C.

V		K_n	Average K_n
Sodium ethylate	Sodium iodide		
32	32	0.08995	
		0.09002	0.08998
32	32/3	0.07795	
		0.07964	
		0.07776	0.07845
32	32/7	0.06964	
		0.06832	0.06898
32	32/15	0.06148	
		0.06199	0.06173
32	32/31	0.05400	
		0.05173	0.05287
16	16	0.08323	
		0.08287	
		0.08381	0.08297
16	16/3	0.07270	
		0.07282	0.07276
16	16/7	0.06596	
		0.06582	0.06589
16	16/15	0.05430	
		0.05561	0.05496
8	8	0.07608	
		0.07651	0.07630
8	8/3	0.06664	
		0.06689	0.06676
8	8/7	0.05765	
		0.05640	0.05702
4	4	0.06972	
		0.06952	0.06962
4	4/3	0.05915	
		0.05942	0.05928

Table CXV

Sodium Ethylate, Methyl Iodide and Sodium Iodide at 25°C.

V			α	$1 - \alpha$	K_n found	K_n calculated	Per cent difference
Sodium ethylate	Sodium iodide	Sodium ethylate in mixture					
32	32	16	0.481	0.519	0.08998	0.09191	-3.10
32	32/3	8	0.393	0.607	0.07845	0.08590	-8.67
32	32/7	4	0.312	0.688	0.06898	0.08026	-14.05
32	32/15	2	0.234	0.766	0.06173	0.07466	-17.32
32	32/31	1	0.148	0.852	0.05267	0.06886	-23.54
16	16	8	0.393	0.607	0.08297	0.08590	-3.41
16	16/3	4	0.312	0.688	0.07276	0.08026	-9.34
16	16/7	2	0.234	0.766	0.06589	0.07466	-11.74
16	16/15	1	0.148	0.852	0.05496	0.06886	-20.19
8	8	4	0.312	0.688	0.07630	0.08026	-4.93
8	8/3	2	0.234	0.766	0.06676	0.07466	-10.58
8	8/7	1	0.148	0.852	0.05702	0.06886	-17.19
4	4	2	0.334	0.766	0.06962	0.07466	- 6.75
4	4/3	1	0.148	0.852	0.05928	0.06886	-13.91

"K_n calculated" is obtained by substituting data in equation for K_n discussed on page 11.

TABLE [illegible]

PERSON TRAINING, SENIOR LEADER AND TRAINEE LEVELS AS ESTIMATED.

Table CXVI

Sodium Ethylate, Methyl Iodide and Sodium Iodide at 35°.

V			α and α'	1 - α	K_n found	K_n' calculated	Per cent. error
Sodium ethylate	Sodium iodide	Sodium ethylate in mixture					
32	32	16	0.481	0.519	0.08998	0.0903	-0.2
32	32/3	8	0.393	0.607	0.07845	0.0828	-5.2
32	32/7	4	0.312	0.688	0.06898	0.0748	-7.7
32	32/15	2	0.234	0.766	0.06173	0.0658	-6.2
32	32/31	1	0.148	0.852	0.05387	0.0548	-3.4
16	16	8	0.393	0.607	0.08297	0.0833	-0.4
16	16/3	4	0.312	0.688	0.07276	0.0753	-3.2
16	16/7	2	0.234	0.766	0.06589	0.0661	-0.3
16	16/15	1	0.148	0.852	0.05496	0.0551	-0.5
8	8	4	0.312	0.688	0.07630	0.0761	+0.3
8	8/3	2	0.234	0.766	0.06676	0.0669	-0.2
8	8/7	1	0.148	0.852	0.05702	0.0557	+2.3
4	4	2	0.234	0.766	0.06962	0.0683	+2.0
4	4/3	1	0.148	0.852	0.05928	0.0570	+4.0

"K_n' calculated" is obtained by substituting the necessary data in the equation for K_n' on page 13.

Table III

Sodium Ethylate, Methyl Iodide and Sodium Iodide at 50°.

Sodium ethylate	Y: Sodium iodide	Y: Sodium ethylate in liters	α and α'	$1 - \alpha$	Σ_x found	Y_x' calculated	Per cent. error
35	35	18	0.461	0.539	0.09965	0.0903	-0.1
35	35/2	3	0.388	0.607	0.07848	0.0883	-0.3
35	35/7	4	0.313	0.686	0.06660	0.0748	-7.7
35	35/15	3	0.334	0.738	0.07375	0.0866	-6.1
35	35/41	1	0.148	0.684	0.06367	0.0841	-0.1
18	18	8	0.388	0.607	0.06667	0.0660	-0.4
18	18/3	4	0.313	0.688	0.07378	0.0783	-6.1
18	18/7	3	0.334	0.738	0.06663	0.0861	-0.1
18	18/41	1	0.148	0.683	0.05469	0.0831	-0.3
8	8	4	0.313	0.688	0.07830	0.0781	+0.3
8	8/3	3	0.334	0.738	0.06878	0.0866	-0.1
8	8/7	1	0.148	0.683	0.06706	0.0860	+0.1
4	4	3	0.334	0.738	0.06863	0.0863	-0.1
4	4/3	1	0.148	0.683	0.05660	0.0878	-0.1

"Y_x' calculated" is obtained by substituting the measured [illegible] in the equation for Y_x' on page 17.

CONCLUSIONS.

1. It has been shown that methyl iodide reacts at 0° with sodium, potassium and lithium ethylates. The velocity can be expressed as functions of the concentrations of both the ethylate ions and the nonionized salts.

2. If the ethylate ion reacts independently with the methyl iodide, we should obtain from all three ethylates the same value for K_i, the reaction velocity of unit concentrations of the ethylate ions and methyl iodide. But different values might be found for the reaction velocities of the three nonionized ethylates, which, of course, do not have the same physical and chemical properties. In confirmation of this theory, we find the values 0.00535, 0.00486 and 0.00533 for K_i, and the values 0.00337, 0.00303 and 0.00199 for K_m.

3. The "salt effect" produced by sodium iodide on the reaction of sodium ethylate and methyl iodide at 35°, has been studied in various concentrations. It has been shown that, besides the "normal salt effect" due to the change in the ionization of the sodium ethylate, produced by the added sodium iodide, there is in addition, a slight "negative abnormal salt effect" which can be expressed as a function of the concentrations of the ethylate ions and of the iodide ions.

1. It has been shown that ethyl iodide reacts at 25° with sodium, potassium and lithium ethylates. The velocity was expressed as functions of the concentrations of both the ethylate ions and the nonionized salts.

2. If the ethylate ion reacts independently with the ethyl iodide, we should obtain from all three ethylates the same value for k_1, the reaction velocity of unit concentrations of the ethylate ions and ethyl iodide. The different values that are found for the reaction velocities of the three nonionized ethylates, which, of course, do not have the same physical and chemical properties. In application of this theory, we find the values [illegible], [illegible] and [illegible] for k_1, and the values [illegible], [illegible] and [illegible] for k_2.

3. The "salt effect" produced by sodium iodide on the reaction of iodide ion [illegible] and [illegible] iodide at 25°, has been studied in various concentrations. It has been shown that, instead the "normal salt effect" due to the change in the conductivity of the iodide ethylate, produced by the sodium iodide, there is in addition, a slight "negative substrate salt effect" which can be expressed as a function of the concentrations of the ethylate ions and of the iodide ions.

BIOGRAPHY.

Bessie Marion Brown, the author of this dissertation, was born in Rye, New Hampshire, July 31, 1884. She received her early education in the public schools of that town, her high school training at Newburyport, Massachusetts, and the degree of B.S. from Simmons College, Boston, Massachusetts, in 1907. After holding an instructorship in chemistry at the latter institution for four years, she entered Johns Hopkins University in 1911 as a graduate student in chemistry with physical chemistry and elementary applied electricity as minor subjects. In 1911-13 she was appointed a university scholar.